ECC Report 195

Minimum Set of Quality of Service Parameters and Measurement Methods for Retail Internet Access Services

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0 EXECUTIVE SUMMARY

The purpose of this report is to provide information on best practices for monitoring the quality of retail internet access services and recommend a harmonized minimum set of parameters and measurement methods to achieve this goal.

The Internet has become increasingly important and the number of applications based on the Internet continues to rise. Along with the growing popularity of the Internet and growing demand for these applications, the number of complaints about the quality of Internet access services increases correspondingly. Although there are many different tariffs and products offered by Internet access service providers, information about the quality of those services are rarely given, or the information cannot easily be compared with any other offer thereby limiting the ability of consumers to inform their decision making. If a common set of quality of service parameters and measurement methods existed, consumers could make more informed choices and a corresponding reduction in complaints could be expected.

Article 22 of the Universal Service Directive requires Member States to "*ensure that national regulatory authorities are […] able to require undertakings […] to publish comparable, adequate and up-to-date information for end-users on the quality of their services […]*". Article 22 also states that *"regulatory authorities may specify […] the quality of service parameters to be measured"* and that *"authorities are able to set minimum quality of service requirements"*. Therefore, facilitating comparability and supporting NRAs in the selection of information to be published are very important actions in order to fulfil the requirements of the Directive.

This report summarises current practices by Member States and recommends converging actions towards a more consistent and harmonised approach in the future. Possible parameters, measurement configurations and other aspects relevant for the evaluation of quality of service of Internet access services are discussed. With reference to previous experiences by Member States, a minimum set of standardized parameters is selected to become the baseline for evaluating of the quality of Internet access services. The measurement configurations to be considered can be divided into "in-net" measurements and "over-the-top" measurements. The in-net measurements cover the area of influence of Internet service providers, while over-the-top measurements are more closely related to the end user's perspective. Termination units are assessed before an appropriate form of presentation of the results is considered. In addition, complementary measurement methods mirroring the perception of the end user are presented.

The main conclusions of the report are:

What parameters should be measured, how should they be measured and where should they be measured? These are essential questions for receiving comparable information on the quality of Internet Access Services. The presentation, form and observed values must also be presented in a harmonised way to inform decision making by the consumer.

Parameters about transmission speed, delay, delay variation, packet loss ratio and packet error ratio are necessary for evaluating the quality of retail Internet access services.

In addition to those technical parameters, NRA's are free to observe and evaluate more technical and/ or administrative parameters.

Measurements within the "ISP-leg" are the most comparable, but a better figure of the performance experienced by the end user can be achieved using end-to-end/over-the-top measurements.

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LIST OF ABBREVIATIONS AND DEFINITIONS

Abbreviation	Explanation
Active Method	Intrusive, measurement method possibly influencing normal service provision
ASP	Application Service Provider
BEREC	Body of European Regulators for Electronic Communications
CAP	Content or Application Provider
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DSL	Digital Subscriber Line
ETSI	European Telecommunications Standards Institute
ETSI EG	ETSI Guide
ETSI ES	ETSI Standard
ETSI TS	ETSI Technical Specification
IAS	(Retail) Internet Access Service
IP	Internet Protocol
IPDV	IP Packet Delay Variation (Delay Variation)
IPER	IP Packet Error Ratio
IPLR	IP Packet Loss Ratio
IPTD	IP Packet Transfer Delay
ISP	Internet (Access) Service Provider
ITU-R	ITU Radiocommunication Sector
ITU-T	International Telecommunication Union – Telecommunications Standardization Sector
IXP	Internet Exchange Point
MO	Measuring Organization, i.e. NRA, other relevant national institutions or an independent organization measuring or determining the measurement methods
MOS	Mean Opinion Score
NRA	National Regulatory Authority
NTP	Network Termination Point
NTU	Network Termination Unit
Passive method	Not intrusive, measurement method not influencing the normal service provision
QoS	Quality of Service
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
USD	Universal Service Directive (2002/22/EC) amended by the 2009/136/EC Citizen's Rights Directive
VOI	Voice over Internet
WG NaN	Working Group Numbering and Networks (within the CEPT)
WG NaN PT TRIS	Project Team on Technical Regulatory Issues

1 INTRODUCTION

There is no doubt that publicly available, easily comparable and adequate information about the Quality of Service of Retail Internet Access Services (IAS) provided would contribute to more informed decision making by consumers when selecting from available Internet Access offers. This in turn will contribute to a more positive experience for the end user when consuming Internet Access Services. These reasons are of crucial importance in the overall context of broadband promotion.

At the moment end users are faced with difficulties if they decide to subscribe to an IAS since it is quite challenging to compare, in an objective way, the technical characteristics (mainly transmission speed) of different service offerings from different Internet Access Service Providers (ISPs). There are three main reasons explaining this problem:

1. ISPs are measuring (if at all) different sets of Quality of Service (QoS) parameters;
2. Non-harmonized definitions and methodologies applied for the measurement of the QoS parameters give non-comparable values among different ISPs even in case of similar QoS parameters;
3. Consolidated information regarding QoS values from different ISPs is available in just a few countries across Europe.

A survey based on a questionnaire (see Annex 1) shows that many NRAs (or other relevant national institutions), have established their own QoS measurement methods and tools to evaluate QoS parameters of IAS. It is still a common practice that within the same country different ISPs and NRAs (or other relevant national institutions) measure QoS applying different methods, e.g. measurements are performed between different points in the networks. This approach implies that consumers cannot easily compare IAS provided by different ISPs in order to make a more informed choice.

Moreover, there is also no common approach among NRAs (or other relevant national institutions) on measurement methods, which implies that offers from ISPs from different countries cannot be compared. This makes price and quality of service benchmarks between countries less reliable.

The 2002/22/EC Universal Service Directive (as amended by the 2009/136/EC Citizen's Rights Directive) contains some tools to empower consumers to make more informed decisions regarding their choice of ISP and subscription. This report explores different options and the technical impacts on how NRAs (or other relevant national institutions) in practice can apply these provisions and at the same time address the three problematic areas identified above.

It should be noted as well that for policy and regulatory aspects in the EU, the Body of European Regulators for Electronic Communications (BEREC)[1] performed some studies on QoS in the context of its work stream on Network Neutrality. This is also an attempt to clarify quality aspects related to the regulatory domain. Whereas the BEREC analysis starts the exercise from the policy and regulatory analysis perspectives, this report is rather pragmatically gathering experience from on-going projects running in different countries and attempts to reflect and converge those generally accepted useful approaches. Both approaches should be seen as complementary to enhancing the single EU communications market.

[1] http://berec.europa.eu/eng/document_register/subject_matter/berec/regulatory_best_practices/guidelines/?doc=1101

2 THE AIM OF THE REPORT

The overall aim of this report is to accommodate NRA's (or other relevant national institutions) with the practical application of the EU's regulations on the QoS in order to allow their citizens to make a more objective choice of ISP and type of IAS, not only based on the price, but also on the performance of the connection. For that purpose, the report summarizes and accommodates the experiences and capacities of NRAs (or other relevant national institutions) dealing with quality issues associated with IAS through formulating best practice approaches from the field.

The report names, but does not discuss, the administrative quality parameters which could be used for evaluation of IAS.

The term IAS used through the text of the present report considers Internet Access Service supplied on a retail basis to end users and does not cover cases where Internet Access Services are provided on the basis of non - standard (i.e. not available as ordinary IAS offer) service level agreements between ISPs and end users.

The parameters and measurements described by the report are applicable for IAS offers regardless of the technology used to provide the service[2]. Nevertheless the NRAs (or other relevant national institutions) may still find it useful to distinguish between different technologies while publishing the data and (or) performance measurements of additional technical parameters outside of the scope of the minimum set of technical parameters described in Chapter 5.

The structure of the report after the generic introductory chapters (1- 'Introduction' and 2- 'Aim of the report') is as follows:

Chapter 3 discusses the problem description and policy objectives related to the evaluation of the IAS. This chapter elaborates on the relevant provisions of the USD aimed at addressing the problems defined;

Chapter 4 lists the most relevant quality parameters (technical, administrative and parameters which are applicable for subjective evaluation) which in principle could be used for evaluation of quality of service of IAS. In the case of each parameter, a definition is provided as stated in standardisation deliverables (if available) and any deviations from standards identified in practical implementations at the national level are discussed.

Chapter 5 provides the rationale behind the establishment of the minimum set of harmonised technical parameters and discusses the importance of some technical parameters over others in deciding the composition of the minimum set.

Chapter 6 presents options to determine values to be observed and measurement units of technical parameters discussed in the Chapter 5.

Chapter 7 is dedicated to different aspects of the measurements of the quality of IAS namely: "In-net" quality evaluation scenarios, sampling and representativeness; issues related to performance of measurements in terms of frequency, length, etc. This chapter also provides proposals for the relevant aspects of the measurements which could be considered for harmonization purposes and discusses measurement applications and different termination units which could be used for QoS measurements.

Chapter 8 discusses the practical approach for the presentation of statistical information about IAS to end users with the aim of providing comparable, up to date and adequate information.

Chapter 9 discusses "over-the-top" evaluation methods which could be considered as complementary to the 'in-net' methods discussed in the Chapter 7. These are related to objective test measurements, network management, planning methods and the specific network technologies. Nevertheless, particularly with the diversity of technologies used and the multitude of applications offered to users, it becomes more important to survey parameters reflecting the overall user perception.

Chapter 10 provides the conclusions of the Report.

[2] Mobile and fixed solutions are to be considered.

3 PROBLEM DESCRIPTION AND POLICY OBJECTIVES

There is no doubt that Access to the Internet is gaining significant importance over other retail electronic communications services. The number of IAS end users is growing steadily and quickly. In addition, the number of complaints regarding quality of IAS is correspondingly increasing in some countries. In a few countries the quality of IAS is becoming the dominant concern of end users.

Today end users can choose among numerous IAS offers provided via various access technologies by different ISPs (e.g. ADSL, GPON, DOCSIS, GPRS, Edge, LTE, WIMAX, etc.). The ability to make an informed choice based on available offerings determines, to a significant extent, end user satisfaction with the IAS consumed and is an essential condition for a transparent and fair market operation.

It should also be noted that IAS offers are differentiated not only by price, but also by service quality, where the technical implications are not always understood by end users. Therefore, their ability to make informed choices, as referred to above, depends on number of factors, including the scope of information about quality parameters available, the form and manner of publication of such information and the capacity of the end user to understand the presented information.

Article 22 paragraph 1[3] of Universal Services Directive requires Member States to ensure that undertakings providing publicly available electronic communications services (undertakings) *"publish comparable, adequate [...] information for end-users on the quality of their services"*. In order to reach the objective set forth by the recent provision it is essential to achieve a common understanding in in answering the following three questions:

- What are the QoS parameters to select?
- How should be measured?
- Where should be measured?

It is obvious that without achieving harmonisation in terms of addressing these three questions (firstly at a national level) it is impossible to ensure that QoS parameters measured and published by the undertakings would be comparable and adequate. Inadequate and incomparable QoS information services no purpose in providing end users with the information they need to make an informed choice.

Article 22(1) requires Member States to provide NRAs (or other relevant national institutions) with discretion to decide on the matter to require undertakings to make publicly available certain information about the quality of electronic communications services, including IAS, but does not impose such obligations directly. Therefore the decision to impose this obligation as such should be taken at the national level by each Member State after accounting for national circumstances.

Any steps taken to impose the obligations set out in Article 22(1) should be adequate and proportionate and should aim to address market problems consistent with any other obligations foreseen by the Regulatory Framework of the EU. Absence of publicly available "comparable, adequate and up-to-date information for end-users on the quality of their services" may be considered a problem because it significantly reduces the possibility of the end user to make an informed choice.

While executing its discretion to impose obligations foreseen in Article 22(1), NRAs (or other relevant national institutions) should take account of the views of interested parties. The scope of the interested parties referred to should go beyond the providers of electronic communications services and include organizations and associations representing the interests of end users and ASPs. It is important to consult such organisations and associations because end users and ASPs are precisely the ones that should benefit from the imposition of a proposed regulatory measure. In that context it is important to

[3] USD Article 22 paragraph 1: "Member States shall ensure that national regulatory authorities are, after taking account of the views of interested parties, able to require undertakings that provide publicly available electronic communications networks and/or services to publish comparable, adequate and up-to-date information for end-users on the quality of their services and on measures taken to ensure equivalence in access for disabled end-users. That information shall, on request, be supplied to the national regulatory authority in advance of its publication."

decide on the kind of information to be published and the form of presentation. Chapter 8 of this report discusses this matter in more detail.

In the context of deciding on the publication of QoS information, Article 22(2)[4] provides additional powers to NRAs (or other relevant national institutions) as they *"may specify, inter alia […] the form and manner of the information to be published […] in order to ensure that end-users […] have access to comprehensive, comparable, reliable and user-friendly information".* This recent provision is important in order to harmonise the publication of information by numerous ISPs on the quality of IAS they provide so that published information would be user-friendly and easily comparable.

In summary, it may be concluded that, in the context of the imposition of the obligation of publication of information on QoS of IAS as such, provisions of the Article 22(1) and 22(2) establish sufficient legal reference for NRAs (or other relevant national institutions) in order to:

- ensure that certain information on the QoS of IAS offered would be made publicly available; and
- specify the form and manner of the publication of such information.

Both decisions should be based on national circumstances and should take account of the views of interested parties.

The problem related to implementation of the right of the end user to make informed choice goes beyond simple harmonisation in terms of publication of information on quality of IAS on a national level. It is also important that the information published is easily comparable. In order to ensure such comparability (1) the quality parameters, (2) the definitions of those quality parameters and (3) methodologies used to obtain values of those parameters should be harmonised. If harmonisation of all three positions is reached on the national and international levels then quality of service of all available IAS can be evaluated in the same manner by end users. Such harmonisation is therefore of crucial importance in order to fulfil the policy objective of Article 22(1).

Furthermore, Article 22(2) establishes the right of the NRA (or other relevant national institutions) to specify the "quality of service parameters to be measured" and suggests that "where appropriate the parameters, definitions and measurements methods set out in Annex III may be used". Annex III of the Directive establishes three quality parameters related to access to public communications networks and makes reference to ETSI EG 202 057.

The directive does not specify and in any case does not limit the list of parameters or methods which could be applied, however as the first choice for reference on that matter may be presumed to be ETSI EG 202 057. While ETSI EG 202 057 defines, *inter-alia*, end-to-end measurements, it may be presumed therefore that the active measurement method as well as measurements beyond the ISP leg are considered.

[4] USD Article 22 paragraph 2: "National regulatory authorities may specify, inter alia, the quality of service parameters to be measured and the content, form and manner of the information to be published, including possible quality certification mechanisms, in order to ensure that end-users, including disabled end-users, have access to comprehensive, comparable, Where appropriate, the parameters, definitions and measurement methods set out in Annex III may be used."

4 DEFINITIONS OF PARAMETERS

ETSI and ITU deliverables, namely ETSI EG 202 057, ETSI TS 102 250, ETSI EG 203 165, ETSI EG 202 765, ITU-T Recommendations Y.1540 and Y.1541, establish and define a number of user related QoS parameters[5].

The aim of this chapter is to present an overview of QoS parameters which are related to the quality of IAS and their definitions from the available references given in standardisation deliverables. The purpose of this exercise is to put together all the parameters and their respective definitions from the different references in order to analyse if and how very different approaches are used in defining respective parameters.

Later on those parameters would be used to create the set of parameters to evaluate quality of IAS.

For clarity, QoS parameters are grouped in two generic groups: technical and administrative. Subjectively evaluated QoS parameter, Global user satisfaction, is placed separately at the end of table. Furthermore technical QoS parameters representing similar (or the same) quality characteristics but named and/or defined in different ways in standardization deliverables are grouped in subgroups. Similarly, parameters representing mobile IAS QoS are grouped in a separate subgroup of the group of technical parameters.

Table 1: Definitions of QoS parameters which could be considered for IAS

No.	Parameter	Definition with reference	Notes
	Technical parameters		
1.	**Parameters related to data transmission speed**		
1.1	Data transmission speed	The data transmission speed is defined as the data transmission rate that is achieved separately for downloading and uploading specified test files between a remote web site and a user's computer. (ETSI EG 202 057-04 clause 5.2)	For upload and download
1.2	Mean Data Rate (FTP/HTTP/E-mail)	After a data link has been successfully established, this parameter describes the average data transfer rate measured throughout the entire connect time to the service. The data transfer shall be successfully terminated. (ETSI TS 102 250-2 clauses 6.1.7, 6.8.7, 7.2.8)	This parameter is defined in a standardization document dedicated to mobile Internet access services
2.	**Parameters related to service availability / unavailability**		
2.1	Percent IP service unavailability (PIU)	The percentage of total scheduled IP service time (the percentage of T_{av} intervals) that is (are) categorized as unavailable using the IP service availability function. (ITU-T Recommendation Y.1540 clause 7.2)	

[5] The ITU and ETSI standardisation deliverables are normally free of charge and are available at: http://pda.etsi.org/pda/queryform.asp; http://www.itu.int/en/ITU-T/publications/Pages/recs.aspx

No.	Parameter	Definition with reference	Notes
2.2	Service availability	Service availability (time end-users can use the service) is the arithmetic mean from the total number of service availability calculated results during one payment cycle. Service availability during the payment cycle is determined in accordance with the formula: $p = \frac{T}{t_k \cdot n} \cdot 100\%$, where p – Service availability as a percentage; T – Total time of service availability in hours; t_k – measurement time in hours; n – the total number of network termination points.	Taken from a national regulation
3.	**Parameters related to delay**		
3.1	IP packet transfer delay (end-to-end) (IPTD)	The end-to-end IP packet transfer delay is the one-way delay between the measurement points at the source host address and destination host address (ITU-T Recommendation Y.1540 clause 6.2.)	IPTD is a network performance parameter. The parameter is open for the different protocols to be used.
3.2	Delay	Delay means round-trip delay time in milliseconds between packets sending and receiving from the network termination point to the dedicated point. $\overline{L} = \frac{\sum_{i=1}^{n}(t_{1i} - t_{2i})}{n}$, where $\overline{L}$ - average Delay in milliseconds at measurement time; t_1 - the packet receiving time in milliseconds; t_2 - the packet sending time in milliseconds; n - the total number of transmitted packets during the measurement time.	Taken from a national regulation. This parameter is similar to 3.4, but is open for use with different protocols.
3.3	Delay (one way transmission time)	The delay is half the time in milliseconds that is needed for an ICMP Echo Request/Reply (Ping) to a valid IP address. (ETSI EG 202 057-04 clause 5.5).	3.3 and 3.4 are the same methodology, but 3.3 is half of 3.4
3.4	Ping Round Trip Time	The round trip time is the time required for a packet to travel from a source to a destination and back. It is used to measure the delay on a network at a given time. (ETSI TS 102 250-2 clause 6.3.1)	This parameter is defined in a standardisation document dedicated to mobile Internet access services.

No.	Parameter	Definition with reference	Notes
4.	**Parameters related to delay variation**		
4.1	End-to-end 2-point IP packet delay variation	IPDV is defined in ITU-T Recommendation Y.1540 clause 6.2.4 and explained in more details in ITU-T Recommendation Y.1541 Annex II:	Network performance parameter
4.2	Delay variation	Delay variation is determined in accordance with the formula: $J = \sqrt{\frac{\sum_{i=1}^{n}(L_i - \bar{L})^2}{n-1}}$, where J – Delay variation in milliseconds; $\bar{L}$ - average Delay in milliseconds at measurement time; n – the total number of transmitted packets during the measurement time; L_i -packet Delay in milliseconds.	Taken from a national regulation.
5.	**Parameters related of losing information/IP packets**		
5.1	IP packet loss ratio (IPLR)	IP packet loss ratio is the ratio of total lost IP packet outcomes to total transmitted IP packets in a population of interest. (ITU-T Recommendation Y.1540 clause 6.4)	
5.2	Packet Loss Ratio	Packet Loss Ratio means the percentage of lost packets to total number of sent packets. Packet Loss Ratio is determined in accordance with the formula: $Z = \frac{D}{n} \cdot 100\%$, where Z - Packet Loss Ratio as a percentage; n - the total number of transmitted packets during the measurement time; D - number of lost packets during the measurement time.	Taken from a national regulation.
5.3	Unsuccessful data transmission ratio	The unsuccessful data transmission ratio is defined as the ratio of unsuccessful data transmissions to the total number of data transmission attempts in a specified time period. A data transmission is successful if a test file is transmitted completely and with no errors. (ETSI EG 202 057-04 clause 5.3)	5.3 and 5.4 use the same methodology
5.4	Data Transfer Cut-off Ratio [%] (FTP/HTTP/E-mail)	The data transfer cut-off ratio is the proportion of incomplete data transfers and data transfers that were started successfully. (ETSI TS 102 250-2 clauses 6.1.8, 6.8.8, 7.2.9)	This parameter is defined in standardization document dedicated to mobile IAS.

No.	Parameter	Definition with reference	Notes
6.	**Parameters related to errored IP packets**		
6.1.	IP packet error ratio (IPER)	IP packet error ratio is the ratio of total errored IP packet outcomes to the total of successful IP packet transfer outcomes plus errored IP packet outcomes in a population of interest. (ITU-T Recommendation Y. 1540 clause 6.3)	
6.2	IP Packet error Ratio (IPER)	IP Packet error Ratio (IPER) means the percentage of errored packets to total number of sent packets. Packet Error Ratio is determined in accordance with the formula: $IPER = \frac{E}{n} \cdot 100\%$, where IPER - Packet Error Ratio as a percentage; n - the total number of transmitted packets during the measurement time; E - number of errored packets during the measurement time.	Taken from a national regulation.
7.	**Parameters applicable to Internet access services that are accessed via a login process**		
7.1	Login time	The login time is the period starting when the data connection between the test-PC and the test-server has been established and finishing when the login process is successfully completed. (ETSI EG 202 057-4 clause 5.1)	
7.2	Successful log-in ratio	The successful log-in ratio is defined as the ratio of successful log-ins to access the Internet when both the access network and the ISP network are available in full working order. (ETSI EG 202 057-4 clause. 5.4)	
8.	**Parameters related to access to DNS services**		
8.1	DNS host name resolution failure ratio	The DNS host name resolution failure ratio is the probability that a host name to host address translation of a DNS resolver was not successful. (ETSI TS 102 250-2 clause 5.10)	
8.2	DNS host name resolution time	The DNS host name resolution time is the time it takes to perform a host name to host address translation. (ETSI TS 102 250-2 clause 5.11)	

No.	Parameter	Definition with reference	Notes
9.	**Parameters applicable for mobile Internet access services**		
9.1	Service non-accessibility (FTP/HTTP/E-mail)	The service non-accessibility ratio denotes the probability that a subscriber cannot establish a PDP context and access the service successfully. (ETSI TS 102 250-2 clauses 6.1.1,6.8.1, 7.2.2)	
9.2	Setup time (FTP/HTTP/E-mail)	The setup time describes the time period needed to access the service successfully, from starting the dial-up connection to the point of time when the content is sent or received. (ETSI TS 102 250-2 clauses 6.1.2, 6.8.2, 7.2.3)	
9.3	IP-Service access failure ratio (FTP/HTTP/E-mail)	The IP-service access ratio denotes the probability that a subscriber cannot establish a TCP/IP connection to the server of a service successfully. (ETSI TS 102 250-2 clauses 6.1.3, 6.8.3, 7.2.4)	
9.4	IP-Service setup time (FTP/HTTP/E-mail)	The IP-service setup time is the time period needed to establish a TCP/IP connection to the server of a service, from sending the initial query to a server to the point of time when the content is sent or received. (ETSI TS 102 250-2 clauses 6.1.4, 6.8.4, 7.2.5)	
9.5	Session failure ratio (FTP/HTTP/E-mail)	The session failure ratio is the proportion of uncompleted sessions and sessions that were started successfully. (ETSI TS 102 250-2 clauses 6.1.5, 6.8.5,7.2.6)	
10	**Administrative / Non-technical parameters**		
10.1	Supply time for residential Internet access	Supply time for residential Internet Access is the duration from the instant of a valid service order being received by an Internet access provider to the instant a working service is made available for use. (ETSI EG 202 057-1 clause 5.2)	
10.2	Fault report rate per fixed access lines	The number of fault reports per fixed access line. (ETSI EG 202 057-1 clause 5.4)	Applicable for fixed Internet access services only
10.3	Fault repair time for fixed access lines	The duration from the instant a fault report has been made to the instant when the service element or service has been restored to normal working order. (ETSI EG 202 057-1 clause 5.5)	Applicable for fixed Internet access services only

No.	Parameter	Definition with reference	Notes
10.4	Response time for operator services	The duration from the instant when the address information required for setting up a call is received by the network to the instant the human operator answers the calling user to provide the service requested. (ETSI EG 202 057-1 clause 5.6)	
10.5	Frequency of End user complaints	The number of complaints logged per customer per data collection period. (ETSI EG 202 057-1, clause 5.9)	
10.6	End User complaints resolution time	The duration from the instant a customer complaint is notified to the published point of contact of a service provider and is not found to be invalid to the instant the cause for the complaint has been resolved. (ETSI EG 202 057-1, clause 5.10)	
10.7	Bill correctness complaints	The proportion of bills resulting in a customer complaint about the correctness of a given bill. (ETSI EG 202 057-1 clause 5.11)	
10.8	Prepaid account credit correctness complaints	The proportion of prepaid accounts resulting in a customer complaint about the correctness of its credit or the charges made. (ETSI EG 202 057-1 clause 5.12)	
11	**Subjective evaluation**		
11.1	Global user satisfaction	Level of satisfaction of the users expressed in MOS (Mean Opinion Scores); see further details in clause 9.2 of the report. Reference standards are in this case: ITU-R BS.1116-1, ITU-R BT.500-13, ITU-T P.800, ITU-T P.910 (see clause 9.3)	

Although the above administrative parameters (Sections 10 of the table) are used for an evaluation of IAS, they are limited to the expression of the ISP's organisational features of the IAS provision e.g. an attitude of ISP's staff to end users, but do not describe IAS as such from the technical perspective. As this document is focused on the evaluation of the IAS from the perspective of technical quality, administrative parameters are considered outside the scope of the document and are not discussed further.

Also, the report is focused on applicable technical parameters regardless of the underlying technology used for the provision of the IAS and applications offered by ASPs.

5 MINIMUM SET OF QoS TECHNICAL PARAMETERS AND OBSERVATION VALUES

As discussed in Chapter 3, Article 22(1) of the USD requires Member States to ensure that undertakings providing publicly available electronic communications services *"publish comparable, adequate […] information for end-users on the quality of their services"*.

The ultimate goal of deciding on minimum scope of information to be presented to the end user is that this information should be understandable. In order to achieve this goal, the number of technical parameters analysed should be kept to a minimum. At the same time it is important to ensure that the minimum set presented provide enough information to allow for the evaluation of Quality of Service of IAS by the consumer.

In Table 1 technical quality parameters, which could be used to evaluate technical characteristics of the IAS, are listed. The list is quite long and may be considered as too technical for "non-professional" end users. Many NRAs (or other relevant national institutions) agree that it is not necessary to publish the complete list of existing parameters in order to provide the relevant information on QoS to end-users and there is no common approach on what set of parameters would be best to achieve the desired objective.

This report therefore assumes that for the general evaluation of the IAS there is no need to evaluate all technical parameters. Therefore this chapter proposes a list of minimum necessary technical parameters that are important for end users to be aware of in order to compare different service offerings.

While considering the composition of these parameters, attention should be given to those technical parameters which are important for the most popular Internet applications. In order to help choose the most relevant parameters, Table 2 highlights the relationship between some technical parameters and the most relevant services provided over the Internet.

Table 2: Relevance of Technical parameters for the evaluation of typical IAS

Service/Application	Data transmission speed		Delay	Delay variation	Packet loss	Packet error
	Downstream	Upstream				
Browse (text)	++	-	++	-	+++	+++
Browse (media)	+++	-	++	+	+++	+++
Download file	+++	-	+	-	+++	+++
Transactions	-	-	++	-	+++	+++
Streaming media	+++	-	+	-	+	+
VoIP	+	+	+++	+++	+	+
Gaming	+	+	+++	++	+++	+++

- : not relevant +: slightly relevant ++: relevant +++: strongly relevant

Source: Based on ETSI EG 202 057-4, ITU-T Rec. Y.1541 and ITU-T Rec. G.1010

Taking into account the information provided in the table it can be concluded that only some of the technical parameters are relevant and need to be selected. The selected parameters should be defined based on relevant international standards, while the presentation of the values should be aimed at non-professional end users (i.e. retail customers).

Table 3 below provides an analysis of the technical parameters which could be selected for the general evaluation of the IAS. This analysis is based on each group of technical parameters listed in Table 1. The conclusions drawn from this analysis are made in two steps. Firstly, each group of parameters is included or excluded based on relevance. Arguments are provided to support each group selected. Then

each parameter within each relevant group is analysed and included or excluded. Again, an argument to support each parameter selected is given.

Table 3: Arguments for inclusion/exclusion of technical parameters in the set for general evaluation of the IAS

Group of parameters	Arguments	Set for general evaluation of the IAS
Parameters related to **data transmission speed**	Why the group **is** selected as relevant: ▪ Most relevant for the user and easy to understand; ▪ Present in nearly every IAS offer; ▪ Influences almost any application over the internet; ▪ May be measured on the network level and can be compared with values obtained on the application level. Which parameter and why it is selected: ▪ Parameter 1.1 from Table 4.1 because it is technology neutral, while 1.2 is adjusted to the mobile IAS; ▪ Already widely in use by many NRAs (or other relevant national institutions), ASPs, independent entities, equipment (e.g. servers) providers, ISPs.	Data transmission speed. It is suggested to rename Data transmission speed as **Transmission speed** with the aim of seeking simplicity of the presentation of the information to the end-user. Definition: the data transmission rate that is achieved separately for downloading and uploading specified test files between a remote web site and a user's computer. (ETSI EG 202 057-04 clause 5.2)
Parameters related to the service **Unavailability**	Why the group **is not** selected as relevant: ▪ In general the term Unavailability as such is understandable from the end users perspective and may be considered to be of huge relevance for the end user; ▪ However the definition of the parameter provided in the standardisation document (2.1 of Table 4.1) does not represent the Unavailability as the end user may normally understand it; ▪ The availability of the service as perceived by the user is also covered by a series of administrative parameters which do not form the scope of this document (e.g. fault repair time, fault report rate, frequency of end user complaints, end user complaint's resolution time) ▪ Measurement methodology described may be considered complicated from the ISP's perspective; ▪ Therefore in order to ensure that Unavailability would be	

Group of parameters	Arguments	Set for general evaluation of the IAS
	represented in a way the end user would perceive it, a new definition and new measurement methodology should be developed and put in place; ▪ It may be concluded therefore that it is not reasonable to include the parameter 2.1 as it is described in standardisation documents due to the above reasons.	
Parameters related to **Delay**	Why the group **is** selected as relevant: ▪ Relevant for the user and easy to understand; ▪ Influences many applications over the Internet, e.g. crucial for most of the time sensitive applications; ▪ However for some of the applications it is typically compensated by advanced traffic management techniques and (or) by the applications themselves; ▪ In most cases these parameters may be measured on the network level and can be compared with values obtained on the application level; ▪ Already widely in use by many NRAs (or other relevant national institutions), operators and by many web based speed meters. Which parameter and Why is selected: ▪ To include the parameter 3.3; ▪ For 3.3 and 3.4, the ICMP protocol is defined for the evaluation on delay, The end user alone may not be able to perform measurements of 3.1 and 3.2, while 3.3 and 3.4 are more easy to understand and use e.g. ping test; ▪ Definitions of 3.1 and 3.2 are open for the different protocols (e.g. TCP/UDP) to be used and therefore can better express real quality of IAS perceived by the end user; ▪ At the same time 3.1, 3.3 and 3.4 are well standardised. While 3.3 and 3.4 are already widely in use by many web based speed meters; ▪ Delay measured as a round trip (Parameters 3.2, 3.3 and 3.4)	IP packet transfer delay (end-to-end) (IPTD) It is suggested to use the term **Delay** when presented to the end users with the aim of seeking simplicity of the presentation of the information to the end-user. Definition: The delay is half the time in milliseconds that is needed for an ICMP Echo Request/Reply (Ping) to a valid IP address. (ETSI EG 202 057-04 clause 5.5).

Group of parameters	Arguments	Set for general evaluation of the IAS
	express both upload and download delays by only one value, which is important to keep the information simple and short. However it is not precise enough and more detailed information about delay could be achieved by measuring and presenting separate upload and download delay values.	
Parameters related to **Delay variation**	Why the group **is** selected as relevant: ▪ Influences some popular application over the Internet, e.g. VoIP, on-line gaming; ▪ For some of the applications it is typically compensated by advanced traffic management techniques and (or) by the applications which run on the application level; ▪ In most of the cases, may be measured on the network level and can be compared with values obtained on application level; ▪ Already widely in use by many NRAs, operators and by many web based speed meters. Which parameter and why it is selected: ▪ To include the parameter 4.1; ▪ 4.1 is well standardized and is already widely in use by many NRAs and operators.	End-to-end 2-point IP packet delay variation. It is suggested to use the term **Delay variation** when presented to the end users with the aim of seeking simplicity of the presentation of the information to the end-user. Definition: defined in ITU-T Recommendation Y.1540 clause 6.2.4 and explained in more details in ITU-T Recommendation Y.1541 Annex II
Parameters related to **losing information / IP packets**	Why the group **is** selected as relevant: ▪ For some popular applications this parameter is crucially important, e.g. VoI. The IP packets can be dropped, e.g. due to the small buffer size or bad radio connection (in case of the mobile IAS), nevertheless at the same time values of the Transmission speed, Delay and Delay variation parameters discussed above could be sufficiently good; ▪ Directly influences few popular applications over the Internet, e.g. most for UDP based applications without the compensation techniques used on the application level; ▪ In some cases it may be compensated (until the certain	IP packet loss ratio (IPLR) It is suggested to use the term **Packet Loss Ratio** with the aim of seeking simplicity of the presentation of the information to the end-user. Definition: Packet Loss Ratio is the ratio of total lost IP packet outcomes to total transmitted IP packets in a population of interest. (ITU-T Recommendation Y.1540 clause 6.4)

Group of parameters	Arguments	Set for general evaluation of the IAS
	break down value is reached) by the applications which run on the application level; ▪ Most cases may be measured on the network level and can be compared with values obtained on application level. Which parameter and why it is selected: ▪ To include the parameter 5.1; ▪ 5.3 and 5.4 use similar methodologies and calculate the loss of the files instead of the loss of the IP packets as is the case for 5.1 and 5.2. For the relevant Internet applications the loss of IP packets is the threshold and not the file; ▪ 5.1 and 5.2 are defined in a similar manner. Therefore it is suggested to use the definition provided in standardisation documents, which is 5.1.	
Parameters related to **errored IP packets**	Why the group **is** selected as relevant: ▪ For the general evaluation on the IAS the above parameters may not be considered enough in all the instances, because decreased quality experienced due to reasons related to the errored packets may occur in cases where values of above parameters are sufficient; ▪ In case of TCP, errored IP packets will be compensated (until the certain break down value is reached) by the packet resending technique; ▪ Directly influences few popular application over the Internet which are UDP based applications without the compensation techniques used on the Application level; ▪ In most cases, may be measured on the network level and can be compared with values obtained on the application level. Which parameter and why it is selected: ▪ To include the parameter 6.1; ▪ 6.1 and 6.2 are defined in a similar manner. Therefore it is suggested to use the definition provided in standardisation documents, which is 6.1.	IP packet error ratio (IPER) It is suggested to use the term **Packet Error Ratio** with the aim of seeking simplicity of the presentation of the information to the end-user. Definition: the ratio of total errored IP packet outcomes to the total of successful IP packet transfer outcomes plus errored IP packet outcomes in a population of interest. (ITU-T Recommendation Y. 1540 clause 6.3)

Group of parameters	Arguments	Set for general evaluation of the IAS
Parameters applicable to Internet access services that are accessed via a login process	Why the group is **not** selected as relevant: ▪ Is not technology neutral since it is applicable just for a few cases of Internet Access offers which require a log in process, e.g. Dial-up; ▪ Even for the Internet Access Service to which a log in is required, this parameter does not influence, to a significant extent, the perception of the Internet Access Service quality.	
Parameters related to **access to DNS services**	Why the group is **not** selected as relevant: ▪ Parameter expresses the technical network performance, but does not directly represent the quality of the Internet applications as such, i.e. shows the performance of the used DNS server which is not about the IAS itself; ▪ Therefore the parameter is more relevant for the network operator to supervise the performance of the network rather than represent the quality of the IAS.	
Parameters applicable for mobile Internet access services	Why the group is **not** selected as relevant: ▪ Consider exclusively quality of the IAS provided over the mobile network; ▪ Therefore cannot be generally applicable to all the IAS offers.	

Numbers of parameters within the table are linked to the numbers of the technical parameters given within the Table 1.

Based on the analysis provided in the Table 3, it may be concluded that 5 groups of parameters are relevant for inclusion in the minimum set for the general evaluation of the IAS. It is obvious however that the list is still quite long and some may be difficult for retail customers to understand. At the same time, it is not deemed possible to diminish the parameter set any further.

It is a common understanding that transmission speed of IAS is the most popular and the most understandable parameter among end users, including non-professional end users. At the same time it is present in every IAS offer advertised and therefore describes each IAS offer available. It may be concluded therefore that transmission speed is de facto being used for the purpose of the basic evaluation of the IAS. And last but not least, in many countries transmission speed of IAS is becoming a dominant concern of end users in many countries. This is evident by a steadily growing number of complaints. Therefore, while considering different alternatives to address the problem of relatively long sets of technical values to measure IAS quality, it is also obvious that any alternative approaches will still include transmission speed.

At the same time when discussing the remaining four groups of parameters, it may be concluded that each group is addressing a particular quality feature which cannot be otherwise visible when presenting the value of this certain parameter. This means that any combination of three parameters (in addition to transmission speed) out of four cannot in all the instances represent a quality decrease due to a network failure defined by the remaining one parameter. For instance, and as it was presented in Table 3, quality decrease experienced due to the reasons related to the delay variation may occur in cases where the values of the other four parameters are sufficiently good. It may be concluded therefore that all four parameters, i.e. Delay, Delay variation, Packet loss ratio and Packet error ratio, are equally important and therefore cannot be discriminated. Based on the analysis provided above, it is suggested for evaluation of the quality of the IAS to stick to the minimum set of five technical parameters suggested in Table 3 as they are defined in the Table 1: Transmission speed, Delay, Delay variation, Packet Loss Ratio, Packet Error Ratio.

6 DETERMINATION OF THE VALUES AND MEASURED UNITS OF PARAMETERS

This chapter presents the options to determine values of parameters of the minimum set suggested in chapter 5. The values may be used for publication of information on the Quality of Service in order to define minimum requirements on QoS in service contracts, etc. Some values of parameters are taken from the relevant standards, while others are taken from national legal frameworks / recommendations on QoS evaluation.

This chapter also analyses different approaches for setting the values of the parameters and will take an attempt to suggest the recommended approach for setting each respective value.

Within this report it is systematically considered that:

- **Average value** of the measured values, where average is calculated as:
  $$\frac{1}{n}\sum_{i=1}^{n} a_i = \frac{a_1 + a_2 + ... + a_n}{n}$$
- **Minimum value** means the highest value of the lower 5% measured values;
- **Maximum value** means the highest value of the lower 95% measured values.

For calculation of the Minimum and the Maximum values provided above, the methodology described in ETSI EG 202 057-4 Annex G could be used.

Table 4: Values and Measured Units to be presented for the evaluation of the quality of IAS

No.	Parameter	Arguments	Suggested Approach for Determination of the Values and Measured Units to be presented
1.	**Transmission speed**	**Maximum value** is not included because: ISPs normally advertise Maximum values which are those values that are misleading sometimes for the end user. It is not critical for the evaluation of the QoS; **Average value**: Represents better the achieved speed and therefore the perception of the Internet access quality; **Minimum value**: It is important information for the end user as most of the Internet applications require certain Transmission speeds, i.e. certain Minimum values of the Transmission speed.	Minimum and Average values expressed in Mbit/s or kbit/s
2.	**Delay**	**Maximum and Minimum values** are not included because: It may be too complicated for the ordinary end user to understand the meaning of the	Average value expressed in milliseconds (ms)

No.	Parameter	Arguments	Suggested Approach for Determination of the Values and Measured Units to be presented
		information provided; Also relevant standardisation documents do not suggest that those values should be included; **Average value**: It provides general information about the parameter; **Comments:** The relevant standardisation documents indicate that the Average Standard deviation should be provided. However for simplicity reasons it is not suggested to include this value.	
3.	**Delay variation**	**Maximum and Minimum values** are not included because: It may be too complicated for the ordinary end user to understand the meaning of the information provided; **Average value**: It provides general information about the parameter. **Comments:** ITU-T Y.1540 6.2.4.2 recommends: The preferred method for summarising the delay variation of a population of interest is to select upper and lower quantiles of the delay variation distribution and then measure the distance between those quantiles. However for simplicity reasons it is not suggested to include such values.	Average value expressed in milliseconds (ms)
4.	**Packet Loss Ratio**	**Maximum and Minimum values** are not included because: It may be too complicated for the ordinary end user to understand the meaning of the information provided; **Average value**: It provides general information about the parameter. **Comments:**	Average value expressed in $x10^{-3}$

No.	Parameter	Arguments	Suggested Approach for Determination of the Values and Measured Units to be presented
		ITU-T Y.1540 6.4 recommends that IP packet loss ratio is the ratio of total lost IP packet outcomes to total transmitted IP packets in a population of interest which corresponds to the recommended average value.	
5.	**Packet Error Ratio**	**Maximum and Minimum values** are not included because: It may be too complicated for the ordinary end user to understand the meaning of the information provided; **Average value**: It provides general information about the parameter. **Comments:** ITU-T Y.1540 6.3 says: IP packet error ratio is the ratio of total errored IP packet outcomes to the total of successful IP packet transfer outcomes plus errored IP packet outcomes in a population of interest which corresponds to the recommended average value.	Average value expressed in $x10^{-4}$

7 MEASUREMENT METHODS

This chapter gives an overview about what has to be considered by establishing the measurements.

Possible scenarios (clause 7.1) of measuring described in the standardisation documents are discussed based on practical experiences collected. A summary of different measurement applications and termination units is then given based on those experiences collected (clause 7.2). Finally, some guidance for sampling is offered (clause 7.3) before the test file is specified (clause 7.4).

7.1 SCENARIOS

A generic overview of the elements and network sections the IAS consists of are illustrated in Figure 1 below:

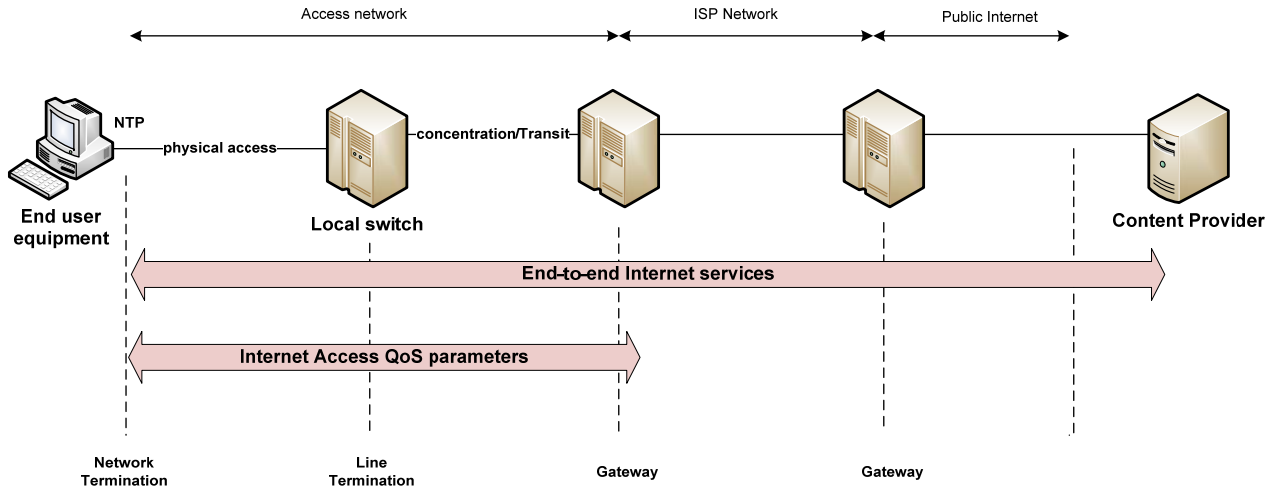

Figure 1: Generic overview of the elements and network sections of the Retail internet access, source: based on ETSI EG 202 057-4, Annex A

From this reference configuration, two groups of scenarios with different subsections appear:

- "in-net" evaluation methods, which are the focus of this chapter, are relevant to measurements in the access network, the concentration access network, the ISP network and, in some cases, the network to national or international internet exchange points (IXP)
  - QoS evaluation within the ISP leg;
  - QoS evaluation between Network Termination Point (NTP) and national IXP(s);
  - QoS evaluation between NTP and international IXP(s).
- "over-the-top" (OTT) evaluation methods, which are the focus of chapter 9, are relevant to the whole network (i.e. the 'end to end' connection), complementing the in-net evaluation by including the network section between IXP and a content provider (e.g. ASP).
  - Distributed approach for QoS evaluation;
  - Collecting information from application provider.

"In-net" evaluation methods used typically between one or a few test servers measuring the selected terminations, whereas "over-the-top" evaluation methods may use one or more servers supporting the QoS evaluation where measurements may be made directly between users' terminals, both at application and network level. As both methods complement each other, it would be of benefit to use measurements from both to assess IAS quality.

7.1.1 QoS Evaluation of the ISP Leg

With the QoS evaluation of the ISP leg, only the network section directly influenced by the ISP will be assessed. The ISP leg consists of the access network part and the ISP network part of the connection of the customer to the ISP.

Definition in standardisation

According to the ETSI guide EG 202 057-4, the measurement set-up shown in Figure 2 consists of a Test-PC connected to the NTP and a test-server at the ISP's backbone. Between those devices, the Test Suits will be established.

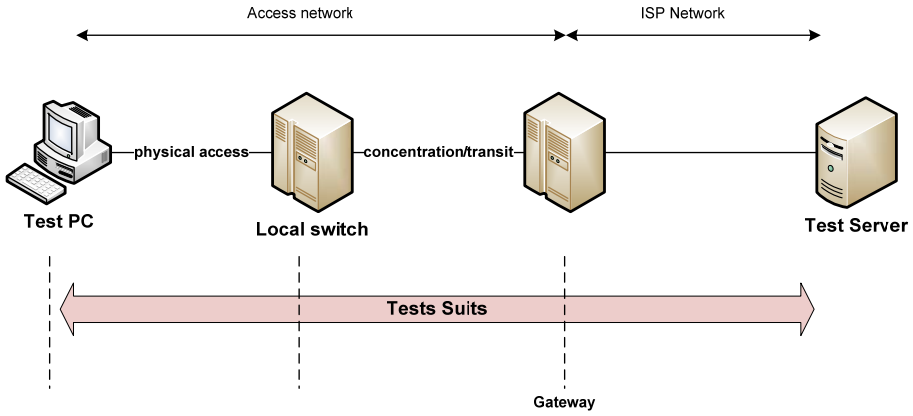

Figure 2: Measurement set-up, source: based on ETSI EG 202 057-4, Annex B

According to ETSI guide EG 202 057-4, the access network is the most essential for assessment of only the ISP leg, which consists of the physical access network and the concentration network. For assessing only the access network, the test-server has to be placed as near as possible to the gateway providing the interconnection between the access network and the ISP network.

Practical experiences and suggested approach for implementation

In practical experiences, remarks appeared for the model for measuring described in the ETSI guide. The test-server has to be connected to nodes within the ISP's network as close as possible to the access network. Furthermore, ETSI defines the values of TCP parameters, for which transmission speed should be measured, whereas in the case in which the test-server was installed as close as possible to the peering gateway, there was no possibility of their settings, moreover, these values were not known. The location of the test server in the ETSI Recommendation is defined as the point of access to the network operator's ISP. The measurement result neither includes the quality of service of the ISP network, nor the quality of service of the Internet network.

Normally the responsibility of the ISP is related with the part of the Internet network it can directly control. Therefore, when applicable, it should perform QoS testing evaluating a set of QoS parameters defined by the NRA (or other relevant national institutions) or, in the absence of this requirement, according to the ETSI guide. The network diagram for this test is represented in the following Figure 3.

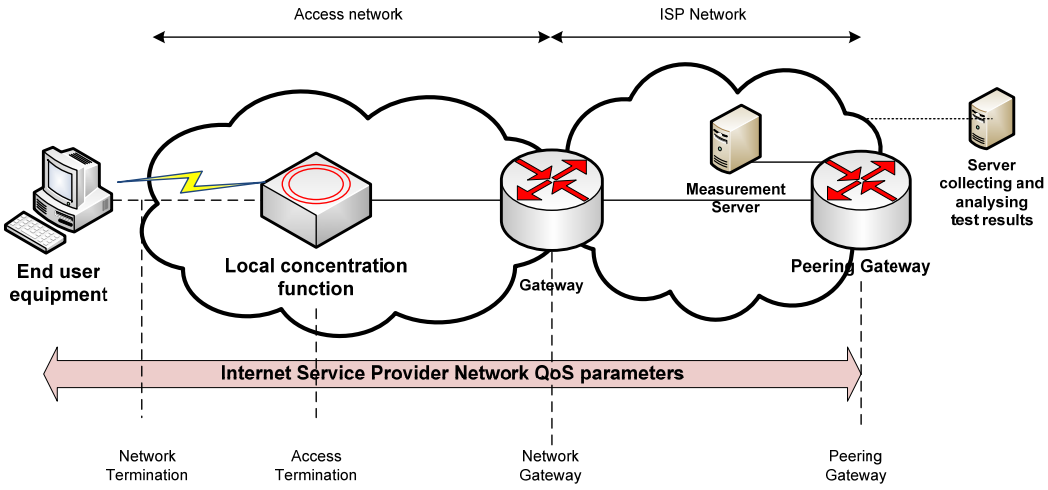

Figure 3: QoS evaluation of the ISP leg

The agreed tests shall be performed by the ISP and the test server shall be connected to the edge of the ISP network. It could also be possible for the user to perform the tests, if the ISP provides a software client or a web based application for this purpose.

Even if the quality of the Internet itself is not contained in the measurements, the quality of the ISP network should be included.

In order to achieve this, the test-server should be placed inside the ISP network. The OSI-layer to measure should be Layer 3.

7.1.2 QoS evaluation of access to a national IXP

In the QoS evaluation of the access to a national internet exchange point (IXP), the test-server is located at a national IXP. This scenario will allow comparing the QoS access to the IXP of the different ISP in a specific country, taking into account a set of parameters specified by the NRA (or other relevant national institutions).

Definition in standardisation documents

No concrete specification of this scenario can be found in the standardisation documents. Therefore this scenario may be considered as the application of the ETSI guidance to a national evaluation point. With regard to the generic overview of the IAS described in Chapter 7.1, the test-server will be placed at a national IXP.

Practical experiences and suggested approach for implementation

In cases where the provider itself measures, as mentioned in Chapter 7.1.1 “QoS evaluation of the ISP leg”, there is a risk that the results will not be comparable. When comparing the IAS with a different ISP, a central test-server is necessary to establish comparable measurement results. A possible location for this central test-server is a national IXP as illustrated in Figure 4.

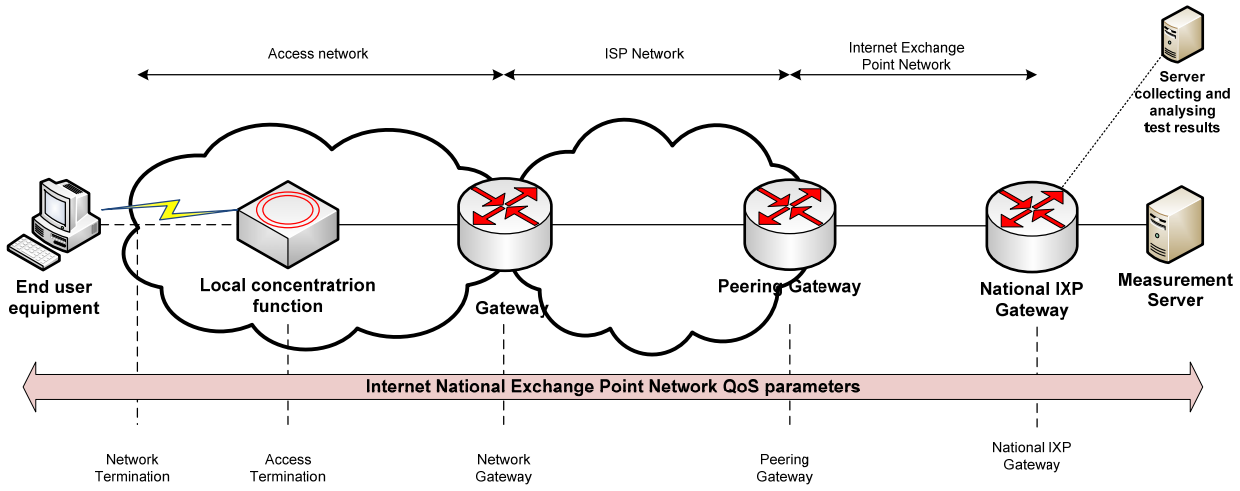

Figure 4: QoS evaluation of access to a national IXP

In this scenario the tests should be preferably be made by the measuring organization, i.e. NRA, other relevant national institutions or an independent organization measuring or determining the measurement methods (MO), using specific tools such as hardware, a software client or web based application. In any case, depending on the test solution, the results could be obtained with different dispersion errors, since the results depend on the sample and on the method.

As practical experiences have shown, the ISP can recognize the location of the test-server, so he can prioritise the connection to and from this test-server. This leads to an increase in the results for this ISP. To counter this, arrangements like a second test-server for reference measurements or various alternate IP-addresses for the test-server must be taken. This arrangement is only possible if the tests are performed by the MO.

This scenario better reflects the performance of the IAS experienced by the end user than the scenario of the ISP leg.

In general the comparability of the IASs can be reached in the best way, if all ISPs are connected on a similar way to the central measuring point, or all ISPs agree on this measuring point. At the same time in the case of bigger countries, there may be few IXPs present or for instance one IXP could be physically distributed and due to that, the ISPs are not connected on a similar way to the central measuring point. However it is widely recognised that the bottleneck of the ISP's network lies within the Access leg and (or) Interconnection points where sufficient capacity does not exist. These bottlenecks do not lie within the backbone of the ISP's network. Measurement results may vary where ISPs are not connected in the same way to the central measurement point. However, the impact of these variations may not be considered significant enough to make the values incomparable

It should also be noted that there may be other significant points, i.e. other than IXPs, where measurements could be performed. In some countries interconnections points other than IXPs could be even more significant than the IXP itself (e.g. interconnection point with incumbent operator).

7.1.3 QoS evaluation of access to an international IXP

In addition to the previous scenarios, it will be possible to define a third scenario taking into account international access. However, it should be noted that the application of this experience could be limited just to one country placing the testing servers in other countries. As several countries are implementing a test server connected to its own national IXP, it could be possible to negotiate among the different countries to allow extending the test parameters to other test servers outside of national territories. This would allow comparisons between the connectivity of Internet access services of different countries and symmetry between pairs of countries could be assessed and a matrix with several tests from several countries could be created.

Definition in standardisation documents

This scenario is not directly specified in the ETSI guide, but rather comes from national experiences of the evaluation of the QoS. Therefore this scenario may be considered as the application of the ETSI guidance to international evaluation points. As can be seen in Figure 5, with international IXP not only one single point is meant, at every IXP a test-server can be installed.

Practical experiences and suggested approach for implementation

The existing scenario with one national IXP will be extended by using international IXP to be able to compare international connections as illustrated below in Figure 5.

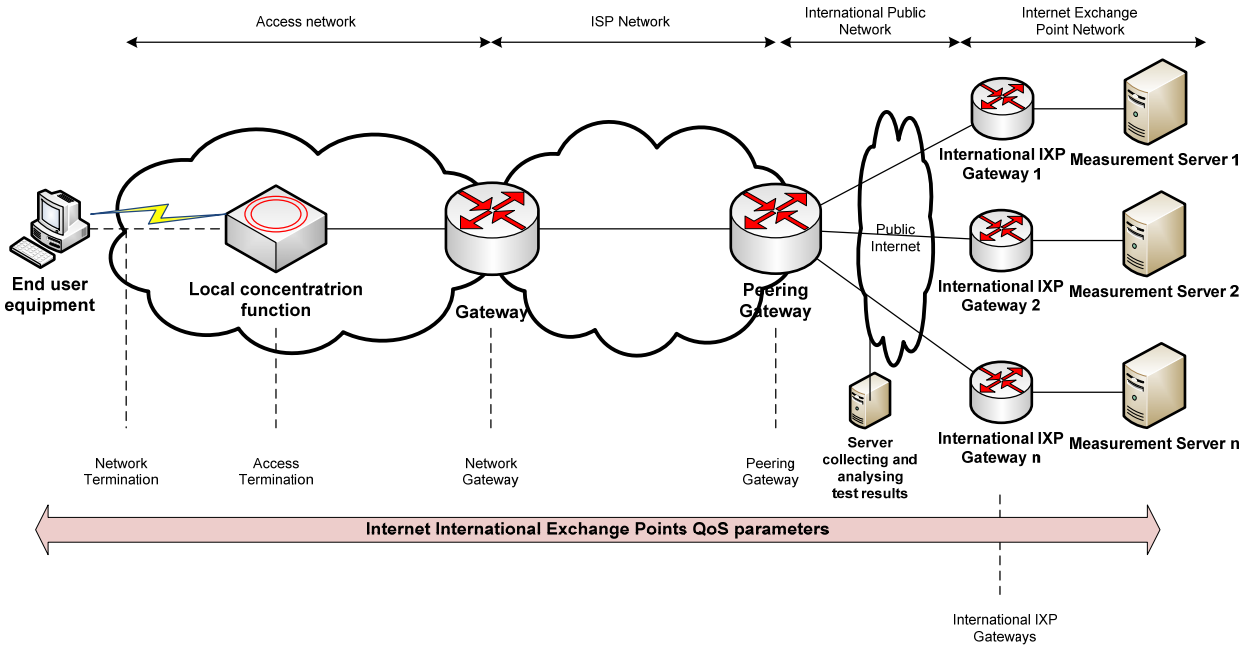

Figure 5: QoS evaluation of access to an international IXP

Even if the international IXP is not a single physical point, the results of the measurements should be collected under a single system of analysis to provide a common set of values that represent the overall performance of each ISP.

From this specification it is easy to understand that whereas the international IXP is expected to be closer to the real perception of the user, a very strong collaboration of all the NRA's (or other relevant national institutions) is required to implement a common set of measures and that such an approach will not be without challenges.

In this scenario the access capacity of the different test-servers should be dimensioned depending on the number of countries accessing the files and also on the number of possible simultaneous tests.

7.1.4 Conclusions of the Scenario chapter

Table 5 should answer the question about how relevant this scenario is for the purpose of providing the end user with comparable, up to date and adequate information about the IAS they have subscribed to.

Table 5: Pros and Cons of different scenarios

In-net Scenarios	Advantages	Disadvantages
ISP leg	A very fair comparison between the networks of ISPs is possible. The liability of the ISP is more evident.	The end user is not really getting the information about the quality of IAS used, because the information that is being measured refers to the ISP network, i.e. very limited part of the Internet network is being measured. Does not consider the bandwith or capacity of connections that the ISP has to the entire Internet. This may be considered important to evaluate because it has a direct impact on the quality of IAS offered, e.g. the more bandwidth or capacity in the connections the ISP has, the better the quality of the IAS offered.
National IXP	Is the most pragmatic and most used approach to evaluate the QoS at present. Also insures fair comparison between the networks of ISPs. Provides possibility to compare the ISPs, because ISPs, directly or indirectly, are connected to the national IXP. This means that the evaluation scenario is the same.	In some cases, QoS information may be misleading. For instance, when the ISP is not connected to the national IXP, but (for e.g.) to an international IXP (or through direct peering), the QoS results for such ISP could be worse. However, this does not necessarily means that the quality of the IAS is worse. In general, the comparability of the ISP can be reached in the best way, if all ISPs are connected in a similar way to the central measuring point, or all ISPs agree on this measuring point. Another scenario is when there are more than one IXP nationally present or if the IXP is physically distributed.
International IXP	The Internet connection which the ISP is providing to the end user is to the entire Internet. The more bandwidth capacity in the connections the ISP has, then the better the Internet connection quality provided by the ISP. The values obtained are one step closer to the end user's perception of experienced quality of the Internet.	From a practical implementation perspective, this approach cannot cover the measurements to all the international connections. Therefore one chosen destination would be discriminated against the others which were not chosen. Having knowledge where the test servers are placed, ISPs may enhance the connections to those particular destinations.

7.2 MEASUREMENTS APPLICATIONS AND TERMINATION UNITS

In principle the measurements could be performed with or without a termination unit. This chapter explores both alternatives and provides information about different termination units which could be used.

In cases where a termination unit is not used, specialized software which is installed on measurement server(s) is used for the purpose of measurements (See Figure 6). Access to this measurement application is arranged via a web page. This kind of application is the most common solution used by MOs. The "speed test" is a good example of this approach. This measurement scenario is realized without termination units and measurements cannot be remotely initialised from the centralised measurement tool via the Internet or another connection to the public network.

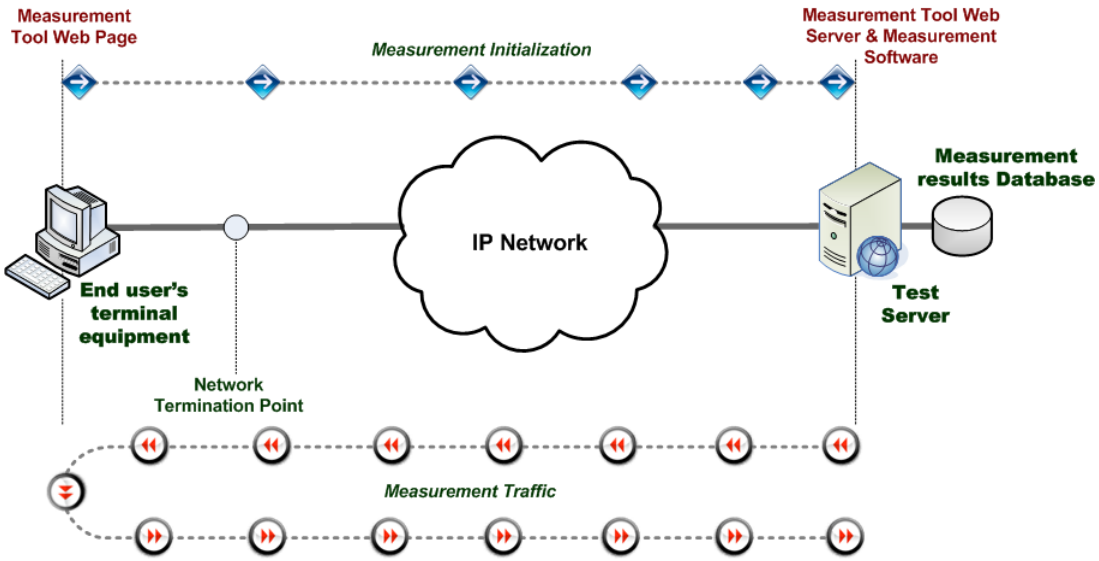

Figure 6: Measurement application

In other cases, measurements of quality of IAS are performed using different types of termination units. In general, the termination unit could be defined as a specialised unit connected to the NTP in the end user premises to provide measurements of quality of IAS. The termination unit may be remotely initialised from the centralised measurement tool via the Internet or another connection to the public network. The following section provides further information on different types of termination units:

a) **Hardware unit specially designed for the measurement purposes**, i.e. co-existing test specific unit placed between NTP and the user's terminal equipment.

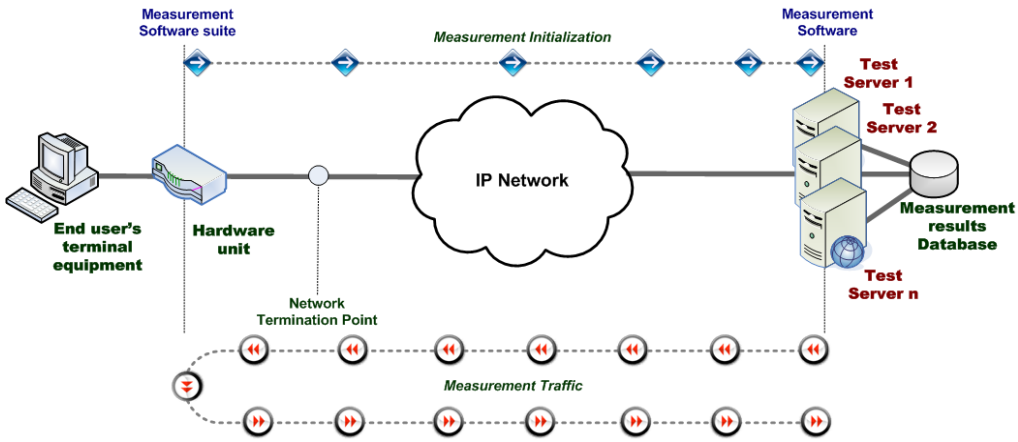

Figure 7: Hardware unit

b) **Software unit** specially developed software for the measurement purposes, i.e. software client installed in end user's terminal equipment.

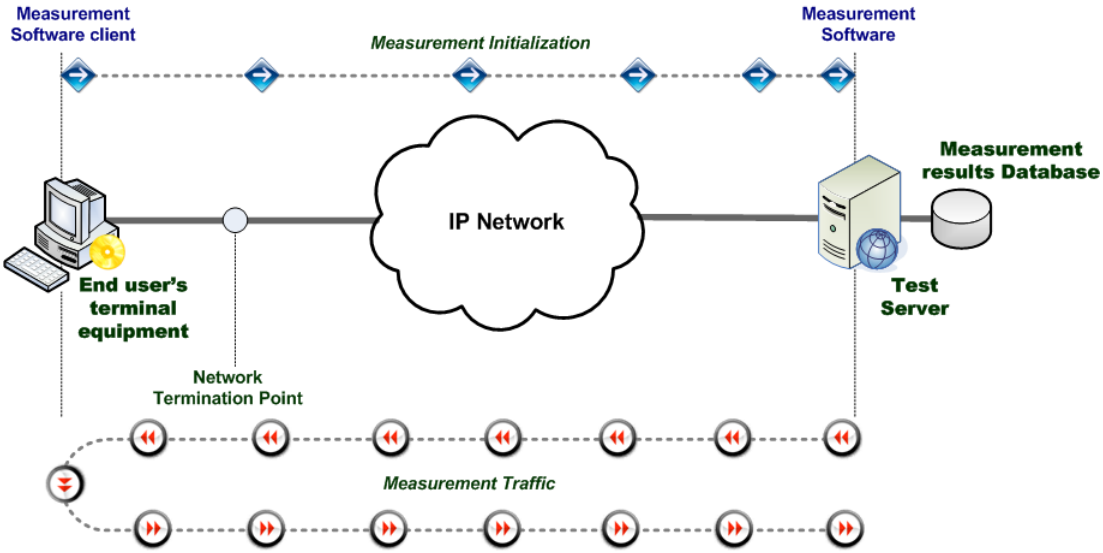

Figure 8: Software unit

c) **Dedicated test specific unit**, i.e. simulator, which is used just for the testing purposes, replacing the end user's equipment. While this equipment performs measurements, no other equipment connected to the NTP can be used. It is applicable also in case of the mobile network.

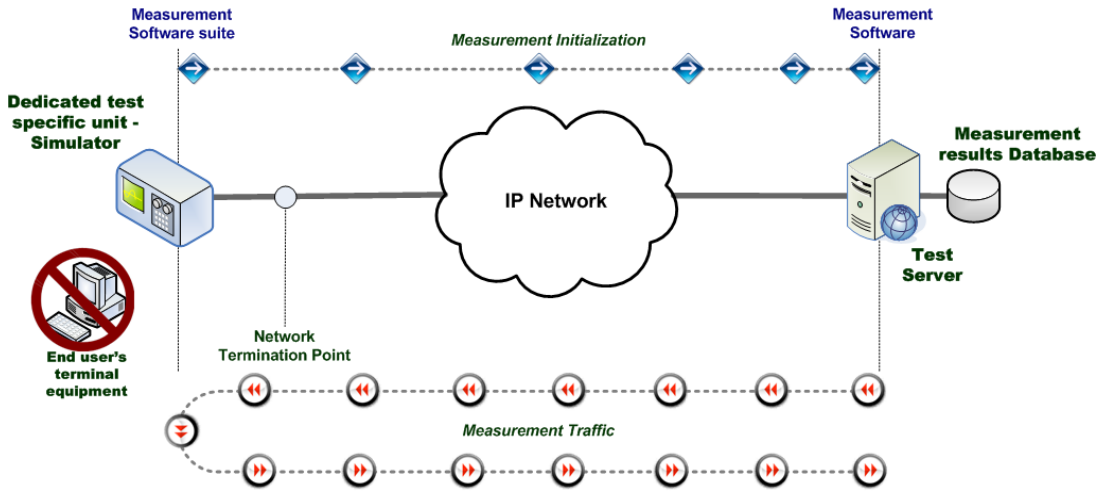

Figure 9: Dedicated test specific unit

d) **Hardware unit, which was designed for other purposes**, i.e. Network Termination Unit (NTU) such as an xDSL modem or optical network unit. These units may have specially modified software to provide measurements. These units normally perform measurements just on the physical level. At the moment these termination units are not recommended as real examples on the market are not known.

Table 6: Pros and Cons of Measurement applications and different Termination Units

No.	Termination unit	Advantages	Disadvantages
0	No termination unit Web based measurement application	Installation is not needed; Is not associated with specific user hardware; Low cost; Facilitates the widest range of users; Has the quickest deployment time.	Can only proceed to measurements and to data collection when the users are on line, needs therefore more collaboration from users. The measurements could be altered if there are other activities on the Internet interface. In case of each measurement, some information regarding the IAS, including contract information, may be required to be introduced (each time when software is used).
1	Software clients	Is not associated with specific user hardware; Lower cost; May facilitate a wider range of users; Likely to have a quicker deployment time.	Can only proceed to measurements and to data collection when the users are on line, needs therefore, in the start-up, more collaboration from users than above case since a software installation is needed. It might be necessary to detect the level of activity of the PC and will require one of the Internet interfaces and will proceed to measurements only when appropriate, i.e. without impairing the user's activity without prior permission; in case of repeated difficulties to measure the requested parameters, messages could be generated inviting users to leave their PC's active for some time without being used. Some information regarding the IAS, including contract information, may be required to be introduced when the software client is being installed.
2	Co-existing Test specific units	Have the possibility of executing measurements during the periods when the users are not actively using their IAS. Measurements are normally made when users are not online and in this case ▪ normally longer test periods are possible and ▪ measurement process does not disturb IAS.	Implies greater costs on hardware and transport; Permanent (7/24) power supply is normally needed; Longer implementation time of the measurement system is required; Installation of the device requires pre-arrangements with each end user separately. Therefore may be practically implemented only on the premises of a limited number of end users.
3	Dedicated test specific unit	Similar to (2) but tests may be performed permanently.	Similar to (2) but requires a dedicated 'line' to connect the termination unit.
4	Network Termination Unit	Low cost if it possible to integrate appropriate test modules in the NTU; May be useful for ISP measurements on their own network.	NTU include tests but they cover normally physical layer parameters; Needs careful verification before being recommended. Many Internet access technologies may not have this capability.

7.3 SAMPLING ACCESS LINES AND MEASUREMENT MOMENTS

Guidance in Annex C of ETSI EG 202 057-04 should be consulted before determining the sample to be considered in the test. ETSI TS 102 250-6 offers a detailed and complex study on statistical methods analysing different type of values obtained in the measurement campaigns.

It is recommended that standards, such as MIL-STD-500 and corresponding updates and complementary recognized documents (MIL-STD-1916 and others), should be consulted before specifying the sampling design. In order to implement a solution in a shorter timeframe it is recommended consult the website 'samknows.eu'[6] and build upon the experiences gained.

It is important that high level confidence intervals are set for the surveillance studies.

Later versions of this report may benefit from the experiences of future studies based on this first version. This first version should start a convergence process of methods currently used by MOs. The document is a validation exercise to specify future quality evaluation campaigns using harmonized methods to obtain comparable results.

Another aspect which may have implications on this subject is a decision on whether it is the ISP or the NRA (or both) who performs the measurements. It is subject to national legislation to decide who will be performing quality measurements of IAS. The USD provides that such measurements should be delivered by undertakings providing public electronic communications networks. However in a number of countries (e.g. Latvia, Lithuania) it is the NRA who is responsible for estimating the quality of IAS. In general there could be three options to arrange measurements as such and each of them has implications in terms of number of measurements, selection of access lines, etc.:

a) measurements performed by the ISPs;
b) measurements performed by the MO;
c) the combination of option (a) and option (b).

If the measurements are arranged or provided by ISPs, the number of measurements calculated may be made according to ETSI EG 202 057-04. However it should be taken into account that it is not possible to make a large number of measurements for small ISPs. According to ETSI EG 202 057-04 the number of measurements does not depend on the number of customers. In such cases, the recommendation could be to reduce the required level of accuracy and/or to set a confidence level. This approach may be used if the measurements are arranged (provided) by MOs, or both – MOs and ISPs.

7.3.1 Selecting Access Lines for Each Speed Range under Study

The main concern should be to have a sample of evaluated users and situations that is representative of the all access lines within the scope of the study, e.g. one provider, one region, one country or the whole of Europe. The biggest is the universe to be analysed, the smaller is the percentage of these units to be evaluated.

In national surveillance studies the percentage of access lines (for each speed range) selected in rural and urban regions should be representative of the national situation. Access lines should not be selected per ISP, except where ISPs are evaluating their own performance or an MO is evaluating a single ISP.

In the case of having too many or not enough voluntary users in a specific region (or regions, e.g. business areas or city centres), the distribution of the access lines (for each speed range) in the country should be studied, prior to validating the measurement campaign. In special cases (relating to certain geographic regions) particular actions to promote the advantages of 'transparency' to consumers may be needed.

For national campaigns (no specific ISP analysis), if the final results for access lines (for each speed range) per ISP correspond approximately to the market share of the ISP, it is likely to mean that the sampling criteria are representative. In the case of under-representation of access lines offered by some ISPs,

[6] https://www.samknows.eu/

consideration should be given to excluding that particular ISP from the campaign or some specific promotion near the clients of that ISP (similar to the 'underrepresented regions').

The aim of the sampling should be to have a stable level for the confidence intervals obtained in different regions and for different ISP's.

There is a difference between fixed and mobile access to internet in selecting the access point. Basically it is possible to measure quality of mobile IAS everywhere where the coverage is ensured. The question is how many places should be selected for the measurements across the country: it may be calculated depending on the size of the country, geographic coverage percentage and classification of rural, urban and suburban areas.

Access point selection for fixed ISPs is, already mentioned, quite a challenging issue, because in order to perform the measurements in most of the cases it is necessary to come inside the customer premises. This problem is faced by both the NRA (or other relevant national institutions) and ISP. This obstacle may be solved through development of co-operation between customers and ISP or MO. Also a call for voluntary users may help to alleviate the problem. Experience accumulated to date in this regard shows that in order to develop co-operation and attract sufficient numbers of volunteers (e.g. students) each attempt should be led by an appropriate advertising campaign and publication of information using different media channels.

7.3.2 Selecting the Measurement Moments

The moments for the measurements should in principle cover high and low traffic, including peak hours. There should be a 'permanent' observation and measurements should be triggered within relatively short time intervals, e.g. every ¼ hour as far as the access line is declared available for measurements. In order to prevent any type of manipulations to effect measurement results from the ISP's side, special measures could be included into a schedule of measurements where, for example, random triggering of measurement can be facilitated.

To obtain representative values in a relatively short period, a permanent observation is recommended, but some of the conceived methods are limited to periods of observation depending on user behaviour.

The frequency of the measurements should be adapted to the number of users participating in the campaign, the option(s) taken for the overall set of measurements and the level of statistical error and confidence intervals acceptable for the project. It is recommended to take decisions in this area only after all relevant options are taken in order to best adapt the frequency.

For simplicity, the measurements may cover only high traffic, including at peak hours. If the IAS is working properly in peak hour (or at least in high traffic hours) the conclusion could be made that quality in low traffic hours should be even more acceptable.

7.3.3 Final Remarks on Sampling and Accuracy of the Measured Values

To obtain smaller margins of error and therefore higher levels of credibility, the specification of the sampling design is extremely important. However, this is only one of the challenges that needs to be addressed in the planned quality surveillance action plan. It is therefore important to start carefully with the actions, considering them as a validation exercise rather than as a recognized evaluation method. Results of these initial campaigns need to be carefully cross checked with results obtained by ISP's, applications providers and other relevant partners (see also Chapter 9 on Complementary Methods).

7.4 SPECIFICATION OF THE TEST FILE

Guidance in Annex D of ETSI EG 202 057-4 could be consulted in order to define the size and type of the test file to download/upload. Annex D considers that the test file should:

- consist of incompressible data (e.g. compressed file like e.g. a zip or jpg file);
- have at least twice the size (in kbit) of the theoretically maximum data transmission rate per second (in kbit/s) of the Internet access under consideration.

8 PRESENTATION OF THE VALUES TO THE END USERS

At the time of drafting of this report, just a few countries in Europe were providing end users with consolidated information regarding QoS values of the IAS. While drafting this chapter, available practical experience was considered.

Proper presentation of the QoS information (values) to the end user may be considered as important as measurement and accuracy of QoS values obtained. Therefore this chapter is aimed at giving appropriate attention to the manner and form of publication of such information. Other matters considered relate to defining national approaches with regards to who should make available (publish) obtained QoS values to the end user.

8.1 PUBLISHING OF CONSOLIDATED INFORMATION ON QoS VALUES

While Article 22(1) of the USD refers to publication of information, it mainly points out that it is the ISPs who may be obliged to publish information regarding the services they provide. At the same time the last sentence of the Article 22(2) provides that such *"information shall, on request, be supplied to the national regulatory authority in advance of its publication".*

Considering the increasing number of ISPs providing IAS, it is not easy for the end user to get up to date information about all offers available, because such information, even if available, is (or will be) distributed to through different media. It is difficult to argue therefore that it would not be of great convenience for the end user to have access to consolidated information regarding QoS values in a single place. The availability of this information will enable the end users to make a more informed choice when selecting an IAS offering.

While Article 22(1) provides NRAs (or other relevant national institutions) with the power to request QoS information, it would be logical to use this provision in order to consolidate and publish information in a single place for ease of access by end users. Another approach would be to publish a list of links to QoS values published by different ISPs. The drawback with this latter approach is that a direct comparison of different IAS offerings becomes more complicated.

8.2 FORM OF QOS MEASUREMENT RESULTS (VALUES) PUBLICATION

In order to ensure easy and visible comparison between QoS values provided by the different ISPs and between different IAS offers of the same ISP, information on QoS measurement results (values) should be published in a similar way. It is common practice amongst NRAs (or other relevant national institutions) publishing such information, to develop a dedicated template for publication of QoS measured values.

This template usually presents a table where IAS offers are structurally split into standard speed ranges (in different rows) and for each speed group defined QoS parameters should be filled (in different columns) (See few examples used in practice in Table 7). The form (template) may split IAS offers not only according to speed groups, but also according to different technologies, or tariff groups. For the measurement methods 0 and 1 listed in Chapter 7, publication of measurement results is managed via a measurement application using specific forms.

Table 7: Examples of the Template forms (tables)

Name of the ISP							
	Protocol: TCP or UDP	Download transmission speed * (Mean and Minimum)[kbit/s] or [Mbit/s]	Upload transmission speed * (Mean and Minimum) [kbit/s] or [Mbit/s]	Delay (Mean) [ms]	Delay variation (Mean)[ms]	Packet Loss Ratio (Mean)	Packet Error Ratio (Mean)
Offer or speed range 1							
Offer or speed range 2							
<...>							
Offer or speed range x							

Transmission speed * range X							
	Protocol: TCP or UDP	Download transmission speed * (Mean and Minimum)[kbit/s] or [Mbit/s]	Upload transmission speed * (Mean and Minimum) [kbit/s] or [Mbit/s]	Delay (Mean) [ms]	Delay variation (Mean) [ms]	Packet Loss Ratio (Mean)	Packet Error Ratio (Mean)
ISP 1-Offer 1							
ISP 1-Offer n (optional if available)							
ISP 2-Offer 1							
ISP 2-Offer n (optional if available)							
ISP n-Offer 1							
ISP n-Offer n (optional if available)							

* Transmission speed is a statistical parameter calculated as an average value to the number of connections. Transmission speed is not the Guaranteed speed. The Guaranteed speed is subject of the exact contract between the end user and ISP.

In Table 8 below speed ranges are presented which are used for the grouping of the IAS offers in practice[7]. However, different alternatives for the speed ranges may be decided depending on national circumstances e.g. on the speed ranges of the commonly used technologies in each country, etc.

Table 8: Example of Transmission speed ranges to group the IAS offers

256 kbit/s | < 2 Mbit/s
≥2 Mbit/s | < 10 Mbit/s
≥10 Mbit/s | < 30 Mbit/s
≥30 Mbit/s | < 100 Mbit/s
≥ 100 Mbit/s

Alternative ways of presenting QoS values may be considered such as using an interactive database containing all the QoS values for different offers and ISPs. Such a database should allow the end user to filter and present QoS values for selected groups of IAS offers and (or) compare offers of different ISPs in a very convenient way.

Whatever form of publication method selected, it should provide comparable results between different ISPs and between different IAS offerings. According to established practice, information on QoS values is being updated and published at least annually.

8.3 OTHER ASPECTS OF QoS INFORMATION PUBLISHING

It is recommended that while publishing information regarding QoS values that information regarding the relevance of particular parameters for typical Internet applications (e.g. Voice over IP, Video over IP) is also published at the same time. ETSI provides some guidance by explaining which parameters are relevant to which application that may be used by end user.

Paragraph 2.4 of ITU-T Recommendation E.800 “Definitions of terms related to quality of service” defines the term QoSO as “QoS offered/planned by service provider”. Publishing of estimated (planned) quality level values may be used according to national legislation. At a later date, when measured values are available for the same time period (e.g. one year), publication of the estimated (planned) values and the measured values may provide the end user with useful information to determine whether their chosen IAS achieved its planned targets or not. See Annex 2 for more information on this approach.

[7] Example of speed ranges used by Latvian NRA

9 COMPLEMENTARY MEASUREMENT METHODS

Chapter 7.1 identified two basic QoS evaluation scenarios: 'in-net' and 'over-the-top'. 'Over-the -top' QoS evaluation scenario refers to methods, covering the whole network (i.e. 'end to end' connection), complementing the 'in-net' evaluation by including the network section between IXP and a content provider (e.g. ASP) (see Figure 1 and Figure 10) or considering the overall connection between 2 users (see Figure 11).

Typically the measurement campaigns explore QoS of IAS provided over different technologies applying 'in-net' QoS evaluation scenarios. An ISP typically surveys "ISP leg" quality and announces offers based on that, but that ISP may have (low cost) interconnection agreements limiting the performance of e.g. video telephony. Specific QoS (QoE) studies may provide evidence of this weakness and hopefully stimulate appropriate corrections thereby enhancing the user's experience.

The purpose of this chapter is therefore to look for possibilities to converge good practices and enhance the confidence of measurement campaigns while obtaining values of QoS parameters more closely related to the end users' experience of quality through 'over the top', i.e. complementary, QoS evaluation methods.

The chapter also discusses 'over–the-top' QoS evaluation methods which are based on existing QoS evaluation practices. However it is recognized, that 'over the top' QoS evaluation methods, when applied together with the 'in-net' methods discussed in Chapter 7, may additionally provide the following benefits:

- Facilitate the development of a more complete set of QoS information about IAS;
- Enhance the diagnostics of the QoS related weaknesses;
- Provide information about the QoS of the IAS perceived by the population;
- When published, enhance QoS information provided to the end user and
- Contribute to (performance based) fair competition.

More established methods are those referred to in the report as 'in-net' measurements which rely more directly on performance of the network layer. However it is recognized that end users may need (and in many cases are willing to obtain) information on QoS that is more directly related to their own experience or related to applications that they most use. It is therefore recommended, in addition to the 'in-net' methods, to perform also complementary 'over-the-top' QoS evaluation.

The majority of the methods discussed in this chapter are based on existing standardisation documents and also correspond to practical experiences gathered from the field. Nearly all of the complementary methods discussed refer to 'over the top' QoS evaluation of IAS.

It is widely recognized, that 'over-the-top' QoS evaluation methods provide QoS evaluation which is much closer to the end user's perception of the IAS. Many services or applications provided benefit from quality enhancing techniques (also referred as traffic management techniques[8]).These quality enhancing techniques are designed to avoid or limit (to the extent possible) the negative impact of poor QoS introduced at network level and enhance the performance of the service or application used. While doing so, quality enhancing techniques may affect technical QoS parameters, (e.g. reduction in the transmission speed or delay variation). Parameters such as Packet Error Ratio, Packet Loss Ratio and Delay variation (when measured at "ISP leg" or at network level) may not be representative of the end user experience.

For these reasons technical QoS parameters suggested for the Minimum Set, i.e. Transmission speed, Delay, Delay Variation, Packet Loss Ratio and Packet Error Ratio are considered 'universally applicable objective parameters'. In order to ensure that both 'over-the-top' and 'in-net' QoS evaluation methods are comparable and therefore complementary and consistent, it is suggested that both Minimum Set of technical QoS parameters should be evaluated when applying 'over-the-top' QoS evaluation methods.

[8] i.e. error correction, packet reconstruction, buffering, etc.

In general the following 'over-the-top' QoS evaluation methods may be identified:

- Distributed, based on automatic collection and analysis of technical information;
- Subjective, based on end user's satisfaction measured by subjective evaluation of the service or a particular application.

9.1 DISTRIBUTED MEASUREMENTS

There are four scenarios how distributed measurements could be organized:

1. Decentralized measurements made by co-existing test specific units, Dedicated test specific units or Network termination units (see Table 6) distributed among the pre-selected access lines with
   a) Measurements made end-to-end between couples of terminal units sending the measurement results to centralized data collection point where the statistical data is processed or
   b) 'unknown' central measurement point(s) associated with data collection and processing.
2. Decentralized measurements made by a web based measurement application or software clients (See Table 6) installed over pre-selected access lines with
   a) Measurements made (end-to-end) between pairs of measurement applications sending measurement results to a centralised data collection point where the statistical data is processed or
   b) 'unknown' central measurement point(s) associated with data collection and processing.

This chapter also briefly discusses the advantages and risks for systems performing 'over-the-top' QoS evaluation.

When comparing 'over-the-top' QoS evaluation scenarios with 'in-net' scenarios (discussed in Chapter 7.1.4 and summarized in Table 5) the main advantage of 'over-the-top' QoS evaluation is that measurements are performed along the whole 'end-to-end' connection as it is established while the end user consumes certain services or uses certain application. In the case of 'in-net' scenarios only parts (depending on the scenario) of the end-to-end connections referred to above are measured.

Scenarios 1(b) and 2(b) (where 'unknown' central measurement points are used) are illustrated in Figure 10 below. In both scenarios the measurements protocol may be identified and the connections used for the measurement may be associated to preferred routers (e.g. best quality routes). This may result in measurement values could be unrepresentative.

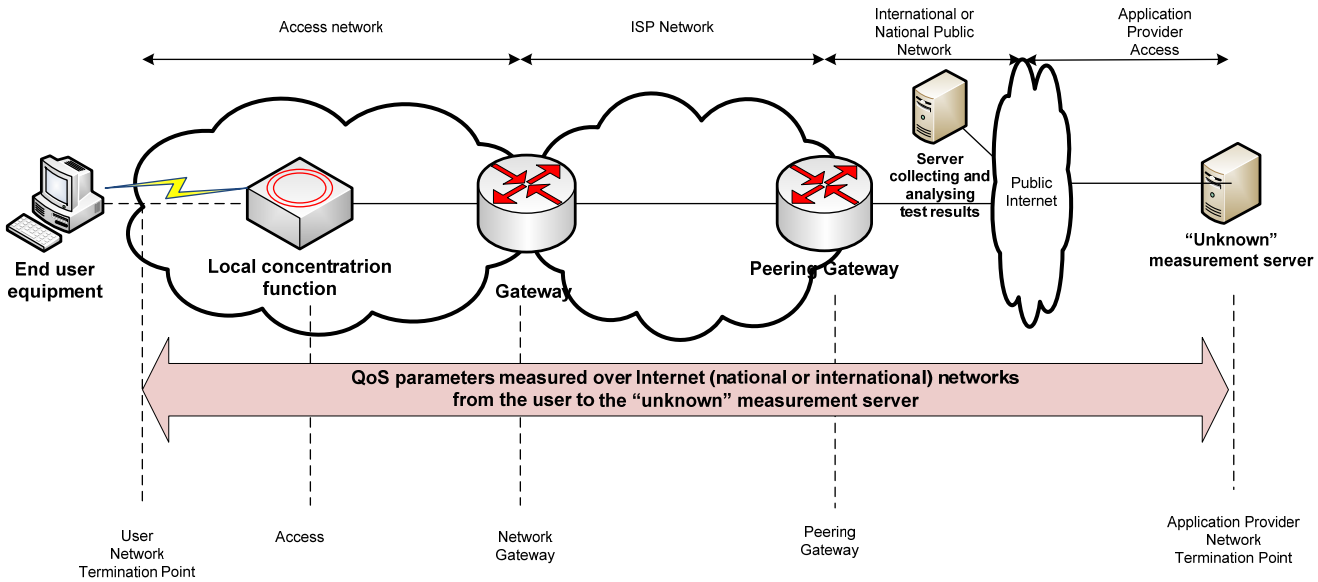

Figure 10: Principle scheme of QoS evaluation applying "'Unknown' central measurement point" method

Scenarios 1(a) and 2(a) (between pairs of hardware or software terminals) are illustrated in Figure 11 below. These approaches are preferred in order to obtain values which represent the situation experienced by the end user. As in the case above, the risk remains that measurement protocols could be identified and also could be associated to priority routes. However since these protocols are used to communicate between a big number of IP addresses and are supposed to cross the networks in 'all directions', it may be assumed that the risk of detection is lower.

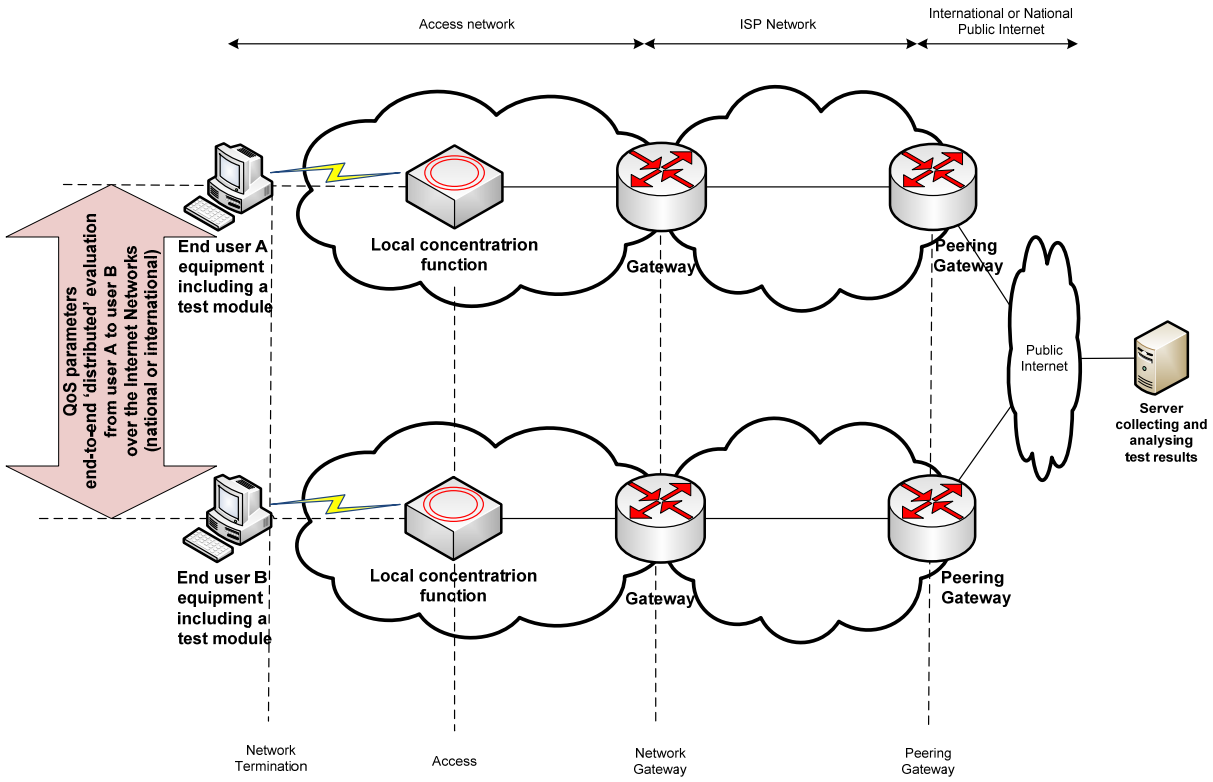

Figure 11: Preferred scheme of QoS evaluation applying "distributed measurements: between couples of terminals[9]" method.

In the case of distributed measurements described it is suggested that the entity performing measurements (MO) would collect values of technical QoS parameters from each ISP (e.g. identified by the IP addresses of exchanged IP packets) and, in order to complement in the best way the 'in-net' measurements, it is suggested that same parameters (See Table 4) would be measured and values obtained would be presented in a similar manner (See Chapter 8.2).

All above alternatives cover 'end to end' performance of IAS and are not related to specific applications. If the ISP discriminates specific applications and /or particular ASP or ASPs (e.g. of TV over Internet or VoI) in terms of QoS and without general deterioration of IP protocols (UDP, TCP or others), this type of impairment will not be detected by the methods mentioned above. In such cases it might be helpful to collect measurement information from ASPs[10].

Collecting information from ASPs allows values of QoS technical parameters to be obtained which closely represent the experience of the end user using the corresponding application. Figure 12 below shows a hypothetical measurement scenario. It may also be presumed that ASPs may be willing to collaborate with the MO in the context of observation of the QoS of IAS provided with the aim of advising their clients of the most appropriate IAS offer in terms of value of technical QoS parameters for their application requirements.

9 particular in the case of low cost software downloaded from a central server

10 possibly on a voluntary basis

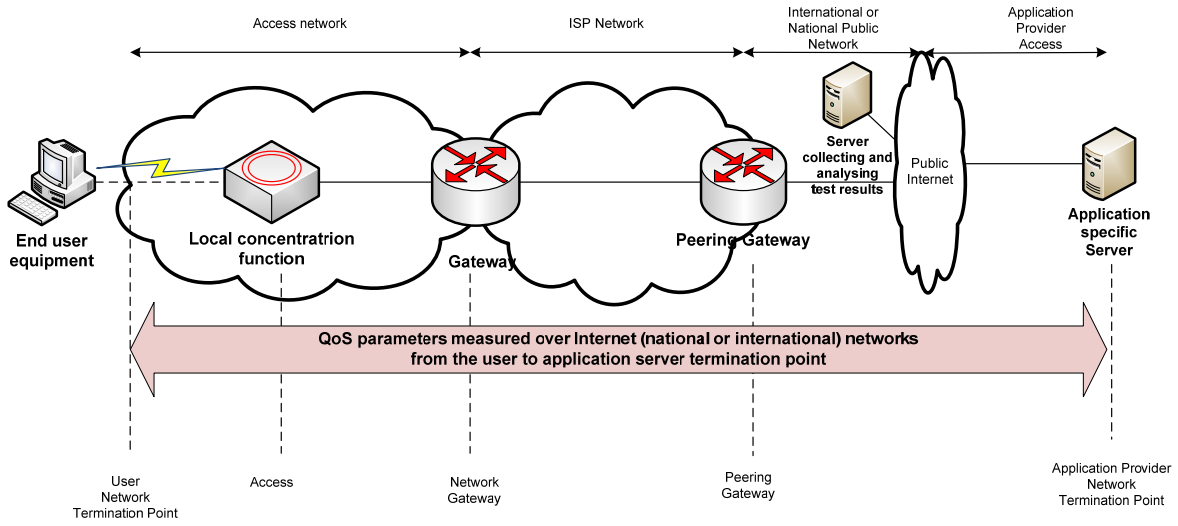

Figure 12: QoS evaluation performed by ASP

As well as in the case of distributed measurements described above, it is suggested that the values of technical QoS parameters would be collected from or submitted by ASPs per ISP (e.g. identified by the IP addresses of exchanged IP packets) in order to complement the 'in-net' measurements. It is suggested that same parameters (see Table 4) would be measured and values obtained would be presented in a similar manner (see Chapter 8.2). It is also believed that the ASPs (normally) can easily correctly identify the ISPs by the Internet addresses of their clients.

9.2 SUBJECTIVE EVALUATION – GLOBAL USER'S LEVEL OF SATISFACTION

Subjective evaluation is one of the complementary QoS of IAS evaluation methods, which aims to measure global users' level of satisfaction. Measurement is performed through obtaining the QoS evaluation directly from the end user while or instantly after the usage of certain application or service over the Internet. Some ASPs use such methods already. The value obtained through such evaluation is known as Mean Opinion Score (MOS).

Subjective methods are used in standardisation in order to establish algorithms relating to an end user's acceptance of a certain service (directly obtained from the end user) and (or) application (e.g. voice telephony, TV, multimedia, etc.) with the technical QoS parameters. Such algorithms, after appropriate validation, provide network operators with the possibility to adjust the technical parameters of their networks with the aim of improving service delivery and achieving the best QoS over the existing infrastructure.

In contrast to other QoS evaluation methods discussed in this report, MOS is directly linked to certain services or applications used. Therefore directly obtained information about the satisfaction perceived may be helpful while complementing 'in-net' QoS evaluation methods with information about QoS experience in the case of targeted services and (or) applications. Such information is helpful in order to identify whether the network environment is favourable for delivery of this specific service and (or) application.

Normally the end user is invited to give an opinion about the technical and / or administrative aspects of the service and (or) application provided:

1. The user is invited to assign a value to the intrinsic / technical performance of the service, e.g. quality of the sound, image or reaction time to the menu offered (this is the main focus of the present report);
2. The user is invited to classify the support administrative services offered by the service provider (ISP or ASP) reaction time of the support services, time to deploy the service, time to answer a complaint, etc. (this is important but not a priority indicator in the present study).

While providing information about end user's satisfaction or otherwise, from the MOS values obtained, it is not obvious whether the responsibility of the QoS relates to the ISP, the ASP or end user. In order to reach the appropriate conclusion it is important to investigate MOS values obtained within the context of all the information on the QoS which could be obtained, including from 'in-net' methods. Subjective methods are helpful to evaluate QoS, but due to the above reasons should not be used as standalone QoS evaluation methods. It might nevertheless be used as a standalone method in a preliminary phase as an indicator, prior to initiating more detailed and expensive surveillance campaigns. Appropriate sampling, careful specification of the parameters to evaluate[11] and carefully chosen conditions for the statistical evaluation methods may significantly increase the credibility of subjective measurements.

Tables 9-1 and I-1 of ITU-T recommendation G.1011, 'Multimedia Quality of Service and performance – Generic and user-related aspects' presents a wide range, comprehensive references and working documents to subjective and objective methodologies to assess Quality of Experience (QoE) associated to different types of services. The most common definition used within the subjective evaluation to define the levels of quality is presented in Table 9.1 below. The scale (from 5 to 1) presented in the Table 9.1 is used throughout a number of ITU recommendations, including:

- ITU-R BS.1116-1, Methods for the subjective assessment of small impairments in audio systems including multi-channel sound systems;
- ITU-R BT.500-13, Methodology for the subjective assessment of the quality of television pictures;
- ITU-T P.800, Methods for subjective determination of transmission quality, telephone transmission quality;
- ITU-T P.910, Subjective Video Quality Assessment Methods for Multimedia Applications.

Table 9: Opinion score levels based on ITU-T recommendations listed above

Global user satisfaction

Level of satisfaction of the end users expressed in MOS (an average of opinions of users within a representative sample); the end user is invited to express his / her level of satisfaction in one of the following 5 levels:

	Score	Overall quality	Impairment	Effort required *
5	☺☼	Excellent	Imperceptible	Complete relaxation possible; no effort required
4	☺	Good	Perceptible but not annoying	Attention necessary; no appreciable effort required
3	😐	Fair	Slightly annoying, acceptable	Moderate effort required
2	☹	Poor	Annoying	Considerable effort required
1	☹💣	Bad	Very annoying	No meaning understood with any feasible effort

** - column is adjusted for voice services. In case of other services and applications values should be adjusted respectively.*

The end user may be invited to express his / her level of satisfaction each time after using certain application or service.

Standardised MOS rating scales are increasingly being used and presently the ITU-T is drafting a report on 'Mean Opinion Score (MOS) Interpretation and Reporting'[12].

[11] Quality of the image / sound, or performance of the users' support service, or satisfaction with billing methods etc.

[12] ITU-T plans to publish the corresponding conclusions in 2013

10 CONCLUSIONS AND RECOMMENDATIONS

1. The report recommends that the Minimum Set of technical QoS parameters consisting of: Transmission speed, Delay, Delay variation, Packet loss ratio, Packet error ratio, should be used and, to the extent possible, harmonized among the CEPT countries for the evaluation of IAS;
2. The Minimum Set is composed to be optimal for evaluation of IAS offers regardless of the underlying network technology;
3. Taking into account the standardisation documents in place and considering the results of the analysis of each of the technical parameters with the aim to provide end user with actual, accurate and user friendly information about QoS of IAS, the following definitions, determinations of the values and measurement units are recommended to be used within the Minimum Set:

No.	Parameter	Definition	Determinations of the values and measurement units
1.	Transmission speed	The data transmission rate that is achieved separately for downloading and uploading specified test files between a remote web site and a user's computer. (ETSI EG 202 057-04 clause 5.2)	Minimum and Average values Expressed in Mbit/s or kbit/s
2.	Delay	The delay is half the time in milliseconds that is needed for an ICMP Echo Request/Reply (Ping) to a valid IP address. (ETSI EG 202 057-04 clause 5.5)	Average value Expressed in ms
3.	Delay variation	For a given pair of IP packets, parameters represent the difference between the delay in one direction, measured for two consecutive packets. (As defined in ITU-T Recommendation Y.1540 clause 6.2.4 and with a calculation method being based on ITU-T Rec.Y.1541 Annex II)	Average value Expressed in ms
4.	Packet loss ratio	The ratio of total lost IP packet outcomes to total transmitted IP packets in a population of interest (ITU-T Rec. Y.1540 clause 6.4)	Average value Expressed in $x10^{-3}$
5.	Packet error ratio	The ratio of total errored IP packet outcomes to the total of successful IP packet transfer outcomes plus errored IP packet outcomes in a population of interest. (ITU-T Recommendation Y. 1540 clause 6.3)	Average value Expressed in $x10^{-4}$

4. The Minimum set of technical QoS parameters could be complemented by additional technical and/or administrative parameters taking into account national circumstances;
5. This report defines two generic groups of QoS evaluation / measurement scenarios:
   1. “in-net” evaluation methods, containing the access network, the concentration network, the ISP network and, in some cases, the network to national or international internet exchange points (IXP); and
   2. “over-the-top” evaluation methods, covering the whole network (i.e. ‘end-to-end’ connection), complementing the in-net evaluation with the network section between IXP (national or international) and a content provider (e.g. ASP);

6. In the context of the “in-net” evaluation methods, it may be concluded that measurements within the ISP leg are the most comparable and directly linked to each ISP; however those results don’t reflect the actual end user’s perception of the IAS used. Measurements to national or international IXPs, which are closer to the end user’s perception of the quality of the IAS, are less comparable mainly due to the different connection of ISPs to the measurement point (IXP). For more information on Pros and Cons of different scenarios see Table 5;
7. QoS measurements can be performed using measurement applications or termination units. In general measurement applications are more convenient to use since they are not associated with specific user hardware, facilitate a wider range of end users and have a quick deployment time. On the other hand termination units can perform measurements independently from the end user (i.e. not only when the end user is on-line) and normally longer test periods are possible. For more information on Pros and Cons of measurement applications and different termination units see Table 6;
8. In order to ensure easy and visible comparison between QoS values provided by the different ISPs and between different IAS offers of the same ISP, such information of QoS measurement results should be published in a similar way and, whenever possible, should be available from a single source;
9. Different forms of publication could be considered, e.g. pre-defined forms (templates), interactive databases. Whatever form of publication of QoS values is chosen, it should provide comparable results between different ISPs and between different IAS offers;
10. It is recommended that ,according to established practice, information on QoS values is updated regularly and published at least annually;
11. The end user may need and in many cases is willing to obtain information on QoS that is more directly related with his / her own experience of IAS usage. It is therefore recommended, in addition to the ‘in-net’ methods, to provide the possibility to perform end user level complementary ‘over-the-top’ QoS evaluation.

ANNEX 1: RESPONSES TO A QUESTIONNAIRE ON QOS FRAMEWORKS AND PRACTICES IN CASE OF RETAIL INTERNET ACCESS SENT ON SEPT. 2011

A1.1 INTRODUCTION

The number of Retail Internet users is growing quickly in nearly every country, together with this number the respective number of complaints regarding the QoS of Internet access is increasing. It is important that regulators dealing with end users' complaints will be able to resolve such complaints in a prompt and transparent manner. In order to cope with this challenge, appropriate QoS requirements (e.g. in case of Functional Internet Access part of Universal Services), as well as efficient technical tools and qualifications need to be ensured in order to investigate QoS complaints.

Considering the stated above, the ultimate objective of the present questionnaire is to collect information from the CEPT Member States regarding the QoS monitoring legal frameworks and technical implementation of measurement systems as much as it is related to QoS of Retail Internet Access.

The questionnaire is organized in two parts: Legal and Technical.

A1.2 RESPONSE TO THE QUESTIONNAIRE

The questionnaire was sent to NaN e-mail list by the ECO on 1st of September 2011. The following 15 administrations have replied: Austria, Croatia, Denmark, Finland, Germany, Latvia, Lithuania, Montenegro, Norway, Poland, Portugal, Romania, Spain, Sweden and Switzerland.

A1.3 DETAILED ANSWERS

1. Is your institution responsible for the supervision of QoS for electronic communications services (e.g. voice telephony or/and Internet Access)?	
Austria	The Universal Service Ordinance defines the quality of the universal service. Article 27 of the Austrian Telecommunications Act mandates that providers of universal services have to publish the achieved performance benchmarks once a year and notify them to the regulatory authority. Furthermore the regulatory authority is entitled to undertake independent reviews of the performance benchmarks to be able to check the accuracy. The quality of other electronic communications services is not regulated.
Croatia	Yes. According to the Law On Electronic Communications, HAKOM as a regulatory authority, is responsible for the supervision of QoS for electronic communications services. HAKOM is also entitled to undertake independent reviews of the QoS parameters to be able to check the accuracy.
Denmark	Yes, but see below (3)
Finland	Yes – to the extent stipulated in our legal instruments. See http://www.ficora.fi/en/index/saadokset/maaraykset.html
Germany	According to § 78 (4) TKG BNetzA may, after consulting the undertaking with universal service obligations, identify the general demand for the universal services among others in terms of the need for quality of service. In this regard, BNetzA has the power to impose obligations on undertakings in order to secure provision of the service and of service features. However, BNetzA may equally choose not to impose such obligations for all or part of its territory if it is satisfied, after consulting the interested parties, that these

	service features or comparable services are deemed widely available.
Latvia	Yes. According to the Law “On Electronic Communications” Public Utilities Commission (PUC) is responsible for the supervision of QoS for electronic communications services
Lithuania	Yes
Montenegro	Yes, it is. In the procedure of expert supervision, the supervisors shall determine the security of networks and services of electronic communications, and compliance with provisions of the Law, concerning confidentiality and secrecy of communications (Law of electronic communications, Article 134, paragraph 6). However, Agency for electronic communications prepare legal grounds for the development of legal acts adopted by the Ministry and in accordance with Law of electronic communications (Law of electronic communications, Article 8, paragraph 3). According of that, Agency is in procedure of preparing legal grounds of Rulebook for QoS for public electronic communication networks.
Norway	Yes
Poland	Yes. UKE oversees the quality of universal service (our own measurement system) and publicly available telecommunication services (we rely on research made by entrepreneurs by themselves). According to the Telecommunication Law 9art. 63), entrepreneurs are required to publish quality indicators of its services. Unfortunately there is no implementing legislation (regulations) to the art. 63 paragraph 3. President of UKE announced in 2008 his position on the list of indicators and parameters describing the quality of telecommunications services - including voice services and service called "Internet connection".
Portugal	Yes. ANACOM issued regulations on QoS regarding voice telephony http://www.anacom.pt/render.jsp?contentId=983509). For Internet access ANACOM published 4 reports, since 2006 to 2010, with QoS test results to market offers. (http://www.anacom.pt/render.jsp?contentId=678378&languageId=1 http://www.anacom.pt/render.jsp?contentId=678244&languageId=1 http://www.anacom.pt/render.jsp?contentId=920605 http://www.anacom.pt/render.jsp?contentId=1056551),
Romania	ANCOM is responsible for implementing art.22 (quality of service) of Directive 2002/22/EC on universal service and users’ rights relating to electronic communications networks and services.
Spain	Yes
Sweden	Yes.
Switzerland	Yes and No. Yes: We supervise the QoS of the universal telecommunications services (statistical indicators). No: However we don’t supervise the QoS of alternative telephony or Internet

	access providers. Remark: a tentative (2009) for including an obligation for service providers with more than 100'000 clients to publish Quality parameters (similar to the USD annex III) was stopped due to the strong opposition from the industry. At present OFCOM studies the possibility of establishing, in collaboration with the industry, a code of conduct specifying the bases for a 'self-regulated regime for QoS transparency'.

2. If not, are there any governmental plans to provide your institution with this responsibility?	
Austria	Due to the transposition of the new EU Telecoms Package into national law it is planned that in the future RTR can by the means of an ordinance define the minimum QoS especially to prevent degradation of the services and the slowing down of data traffic. RTR is likely also to get the competence to offer instruments and control possibilities for users to check the QoS of their services.
Croatia	N/A
Germany	N/A
Portugal	No applicable
Romania	N/A
Switzerland	According to Art 12a of the telecommunication acts the Federal Council may require of telecommunication services to publish information concerning the quality of the services provided by them. Currently it doesn't require it. If the above mentioned tentative to establish a 'self-regulated regime for QoS transparency' will fail, OFCOM will probably come back to propose some specific regulatory measures in this area. .

3. Have any QoS requirements (parameters, Key Performance Indicators (KPI)) been legally established for Retail Internet Access in your country?	
Austria	No
Croatia	Yes
Denmark	No, but current legislation empowers NITA to regulate user access to information, dissemination of information and access to applications and services of the users choice (net neutrality) if deemed necessary. No such regulation is in force at this time.
Finland	Yes – see relevant parts of Explanatory Notes to Regulation 58 http://www.ficora.fi/en/index/saadokset/maaraykset.html
Germany	No
Latvia	Yes, Quality of Services requirements for Internet Access service have been established by Public Utilities Commission' Act and are in force from January 2006.
Lithuania	Yes

Montenegro	Yes we have.
Norway	No legal requirements. But guidelines on “best practice” have been agreed between the regulator, consumer authorities and ISPs on customer service.
Poland	Quality requirements in terms of quality levels were in force until May 2011 under the decision of the President of UKE for universal service. For publicly available services such requirements do not exist. As stated in point 1, a regulation is in preparation, while the President of UKE announced his position on this issue, which is not mandatory. There are the indicators which requirements to publish, what are their definitions, which parameters represent various indicators, what research methods to use, statistical sample size to maintain the required accuracy of research
Portugal	For the Internet access service there is no Regulation in place till the moment establishing QoS requirements. A Consultation process on this issue was already performed in 2006, but it was considered premature at that time.
Romania	Yes
Spain	YES. In order to promote transparency on QoS and to provide end users with comparable, relevant and reliable on the QoS offered by the main service providers, the Ministerial Order ITC/912/2006 on QoS conditions on electronic communications services establishes the conditions to publish comparable, adequate and up-to-date information on QoS and specifies the parameters to be measured and the content and format of the published information. Internet access providers with annual income higher than 20M € shall measure, publish and audit a set of QoS parameters, using a common methodology and common criteria. Furthermore, the MITYC publishes synthesis and comparisons of the data provided by operators (quarterly reports with weighted average data). On the other hand, the Royal Decree 726/2011, amending the R.D. 424/2005 on conditions for electronic communications services, universal service and users’ rights, establishes that the connection providing the universal service shall be capable of allowing broadband data communications at 1 Mbps in download. This speed does not refer to the Internet Access but to the overall speed of the data link to the network and includes both the data transport capability of the link and the overhead (synchronization, control, operations, error correction), or other access-specific functions. For ADSL technology corresponds to the modems’ synchronization speed. For each user the designated operator will ensure that the overall data speed provided by the connection, averaged over any 24 hour period, is not less than 1 Mbps.
Sweden	No
Switzerland	Yes, but only for the universal service obligation for Internet access

4. If yes, Please list such requirements (parameters, KPI) in your answer below and provide the reference to the appropriate legal act which establishes aforementioned requirements.	
Austria	N/A
Croatia	The internet service provider is obliged to state minimum download data rate for his provided internet services in the contract with the customer
Denmark	N/A
Finland	Described in Section 1 of Explanatory Notes to Regulation 58 http://www.ficora.fi/en/index/saadokset/maaraykset.html
Germany	N/A
Latvia	Quality of electronic communications services requirements (http://www.likumi.lv/doc.php?id=234030 [LV]) issued by PUC of Latvia determines the following Internet Access service quality parameters: - Supply time for initial connection, calendar days; - Fault rate; - Fault repair time; - Download and upload speed, Mbit/s - Latency, ms - Jitter, ms - Packet loss, % - Service availability, %
Lithuania	The internet service provider is obliged to state minimum download/upload data rate for his provided internet services in the contract with the customer. Also service availability percentage should be stated in the contract. Electronic Communications Service Rules (Žin., 2005, Nr. 152-5627) 8.1. punktas.
Montenegro	We have Rulebook for quality of service for Universal Service. According to that, one of parameters of quality of services from the scope of Universal Service is data rate. Rulebook for quality of service for Universal Service, specifies that data transfer speed that is necessary for functional Internet access is measured in accordance with definitions and methods specified according to the technical information METI ETSI EG 202057-1, and the exit velocity ("upload) and the input speed ("Download") are measured separately. At least 95% of the line must be achieved data rate required for a functional approach internet.
Poland	Regulation is in preparation. See Annex 1 to the Position of the President of UKE http://www.uke.gov.pl/uke/index.jsp?place=Lead01&news_cat_id=470&news_id=7181&layout=3&page=text and response to point 1.
Portugal	No applicable
Romania	According to the Decision no.1201/2011 (http://www.ancom.org.ro/en/formdata-1130-51-879) on the establishment of quality indicators for the provision of the Internet Access Service and publication of the due parameters[13], the providers of Internet access

	services have the obligation to publish on their own websites, and to include in the contracts concluded with the end-users, respectively in the general conditions for the service provision, a relevant set of indicators and parameters related to the Internet access service quality. They also have the obligation to publish on their websites information on the measurement procedure. Parameters published on the Internet are to be updated on a quarterly basis. The Internet access providers will have the obligation to publish the administrative quality parameters such as: - supply time for providing Internet access; - fault repair time; - frequency of the complaints submitted by users; - frequency of the complaints related to faults; - frequency of the complaints related to the bill correctness; - customers complaints resolution time. Also, according to the decision, ANCOM will create, manage and make available to the users an application meant to real-time measure and assess the technical quality parameters for the Internet access service: - data transfer speed; - transfer delay; - transfer delay variation; - packet loss rate. Regarding the inclusion of the technical parameters in the contracts, the providers will be required to specify the maximum/ nominal transfer speed. The provider will decide whether to include the other parameters (including minimum transfer speed). However, if the provider does not guarantee a value for the parameters, it will have to specify in the contract that it does not guarantee the minimum transfer rate, transfer delay, transfer delay variation or packet loss rate. Providers have the obligation to include in the contracts the levels of service quality **offered to the end-users**. The abovementioned decision doesn't impose any minimum QoS requirements on an undertaking providing Internet Access.
Spain	YES. In order to promote transparency on QoS and to provide end users with comparable, relevant and reliable on the QoS offered by the main service providers, the Ministerial Order ITC/912/2006 on QoS conditions on electronic communications services establishes the conditions to publish comparable, adequate and up-to-date information on QoS and specifies the parameters to be measured and the content and format of the published information. Internet access providers with annual income higher than 20M € shall measure, publish and audit a set of QoS parameters, using a common methodology and common criteria. Furthermore, the MITYC publishes synthesis and comparisons of the data provided by operators (quarterly reports with weighted average data). On the other hand, the Royal Decree 726/2011, amending the R.D. 424/2005 on conditions for electronic communications services, universal service and users' rights, establishes that the connection providing the universal service shall be capable of allowing broadband data communications at 1 Mbps in download. This speed does not refer to the Internet Access but to the overall speed of the data link to the network and includes both the data transport capability of the link and the overhead (synchronization, control, operations, error correction), or other access-specific functions. For ADSL technology corresponds to the modems' synchronization speed. For each user the designated operator will ensure that the overall data speed provided by the connection, averaged over any 24 hour period, is not less than 1 Mbps.
Switzerland	Parameters and statistical performance indicators are defined in section 3.4 of SR 784.101.113/1,2 based on Article 21 of SR 784.101.1 - Ordinance on

	Telecommunications Services. The parameters are: - Data transmission speed - Successful login ration - Bill correctness complaint

5. If not, are there any plans to legally establish QoS requirements for Retail Internet Access in your country?	
Austria	Any further activities in these areas require first a new communications act.
Croatia	N/A
Germany	The revised regulatory framework is currently transformed into national law. In this context, following Art. 22 USD, it is planned to introduce a new § 45o TKG that would allow the Federal Ministry of Economics and Technology to set minimum quality of service requirements on an undertaking or undertakings providing public communications networks in order to prevent the degradation of service and the hindering or slowing down of traffic over networks. According to § 45o (5) TKG the ministry could transfer to BNetzA the ability to decide on whether and which minimum QoS requirements should be set.
Lithuania	N/A
Norway	No
Poland	See Annex 1 and Annex2 to the Position of the President of UKE http://www.uke.gov.pl/uke/index.jsp?place=Lead01&news_cat_id=470&news_id=7181&layout=3&page=text
Portugal	It is under consideration
Romania	N/A
Sweden	No plans for specifying minimum QoS requirements. However PTS finds it important that the end users have information about the service providers´ QoS aspects. For that reason PTS is planning to collect information from service providers on some QoS aspects, for example speed, prioritization and blocking of traffic. The information will be published on PTS Telecom tariff comparison site.
Switzerland	The intension of the 'self-regulated regime for QoS transparency' is not to establish new requirements; it is rather to agree on a set of selected parameters and evaluation methods facilitating the publication of QoS representative indicators to enhance the transparency and allow the user to make better informed decisions.

6. Please specify if the imposition of QoS requirements (parameters, KPI) was introduced following the requirements of the EU regulatory framework or such requirements were introduced as national measure. Please elaborate on the rationale of the imposition of QoS requirements for Retail Internet Access.	
Austria	N/A
Croatia	Requirements were introduced as a national measure. Also it is in line with USO Directive ((quality of service)

Denmark	N/A
Finland	as described in Section 1.2 of Explanatory Notes to Regulation 58 http://www.ficora.fi/en/index/saadokset/maaraykset.html
Germany	N/A
Latvia	The USO Directive authorises NRAs to specify QoS requirements to be measured. On the other hand ETSI EG 202 057 principles were used to specify the most important QoS requirements, which are sensitive for end users.
Lithuania	No requirements were imposed. RRT is conducting regular measurements only of mobile internet access KPIs throughout the year and publishes collected data analysis reports annually.
Poland	When setting a list of indicators guided by the requirements of the new package of directives from 2009 No. 136 and No. 140th (ETSI EG 202 009-2 and ETSI EG 202 057-4 and ITU recommendations) See Appendix 1 See Sections 1 Reply In line with EU requirements in the draft of Telecommunications Law in Article 56 and 63 are applied, among others, requirements on the minimum guaranteed speed of data transmission for Internet access services.
Portugal	Not up to now. Please see the above answer.
Romania	The imposition of QoS requirements was based on art.22 (quality of service) of Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services.
Spain	The only requirement regarding QoS of the EU regulatory framework refers to transparency obligations that shall be imposed on the operator designated for the provision of the Universal Service (article 11.1 of the US directive). Besides that, the EU framework allows (but does not require) MMSS and/or NRAs to impose specific performance targets for undertakings with universal service obligations (article 11.4 of the US directive), transparency requirements on the QoS provided by the undertakings that provide publicly available electronic communications networks and/or services (article 22.1 of the US directive), and to set minimum quality of service requirements on undertakings providing public communications networks in order to prevent the degradation of service and the hindering or slowing down of traffic over networks (article 22.3 of the US directive) The requirements adopted in Spain are based on the above mentioned articles 11.1 and 22.1 of US Directive).
Sweden	Sweden has chosen the approach to let competition work for itself, while the transposition is closely aligned with the directive.
Switzerland	Requirements were introduced as a national measure. The aim is to ensure the quality of the universal service obligation at a reasonable level. The new 'self-regulated regime for QoS transparency' under study aims rather fair competition and transparency on the market.

7. How are published the results of the QoS parameters or KPI? (By the regulator or by each Internet Access Service Provider (ISP) or by somebody else?)	
Austria	N/A
Croatia	The results are published annually by HAKOM on a website. All ISPs have the obligation to send the QoS parameters, which are defined by Ordinance on manner and conditions for the provision of Electronic communications networks and services, for the current year. ISPs provide measurements of QoS parameters by themselves.
Denmark	N/A
Finland	As described in Section 1.2 of Explanatory Notes to Regulation 58 http://www.ficora.fi/en/index/saadokset/maaraykset.html
Germany	N/A
Latvia	According to PUC legal acts all ISPs have the obligation to send the Quality of Internet Access Service declarations to the PUC. ISP have to declare values of QoS parameters, which are defined by PUC, for the current year. ISPs provide measurements of QoS parameters by themselves. At the end of the current year, ISPs have to send the measurement results to PUC. PUC compares all results with the values declared by ISP and publishes on PUC website.
Lithuania	The results are published annually by RRT. The ISPs do not publish the results of their measurements which they conduct for network performance evaluation.
Montenegro	We don't have regulation in area of quality of service yet, but according to the Law of electronic communications operator, providers of public communications services shall be obliged to submit to the Agency, within a deadline defined by the Agency, information on quality of services they provide. The Agency shall publish that information from paragraph 3 of this Article in the form of parallel overview, showing level of quality for the same type of service from different operators/providers.
Norway	QoS parameters on customer service availability and response time according to "best practice" guidelines are published by the regulator.
Poland	According to art.63 paragraph 3 of the Telecommunications Law suppliers have an obligation to publish the indicators. However, few of them do that. UKE publishes half-yearly reports made by an entrepreneur that was designated to implement the universal service. UKE publishes an annual report of its own research on quality of universal service. UKE publishes reports of its own research on voice services quality and Internet access on mobile networks GSM and UMTS..
Portugal	Please see the above answer.
Romania	The administrative quality parameters will be published by the ISP and the technical quality parameters will be published by the regulator.
Spain	Both the regulator and the ISP's publish the results (see 3).
Sweden	Please see answer under question 5.

Switzerland	The results are not published at present. With the 'self-regulated regime for QoS transparency' under study, the initial intension is to have all the information published by the providers themselves, near the offer as a part of the service description and price announcement.

8. Are there any comparability issues between ISPs regarding QoS parameters or KPI?	
Austria	N/A
Croatia	Comparability is a main concern. Methods of measurement are discussed the most (where the measurements should be conducted, what type of data file should be used, etc).
Denmark	N/A
Finland	As described in Section 1.2 of Explanatory Notes to Regulation 58 http://www.ficora.fi/en/index/saadokset/maaraykset.html
Germany	N/A
Latvia	Yes, QoS parameters are comparable between ISPs according to groups of Internet Access speed defined by PUC.
Lithuania	Methods of measurement are discussed the most. What modems should be used, where the measurements should be conducted, what type of data file should be used, etc.
Norway	ISPs are compared on customer service performance, ref. 7
Poland	There are fundamental problems of comparing results, because the provider just does not publish their QoS indicators.
Portugal	Yes, in the context of reports published by ANACOM according above answer to question 1.
Romania	For the moment there are no data regarding the parameters. The first data will be available in the beginning of trimester II 2012.
Spain	Comparability is a main concern, so a QoS working group chaired by the MITYC and composed by service providers associations, users associations, S. U. designated operator and CMT representatives was created under M.O. ITC/912/2006 provisions to advise SETSI on QoS regulation development, elaborate guides, additional requirements and deal with comparability issues.
Sweden	PTS is now investigating if consumers can do informed choices and can compare different QoS parameters, for example limitations of offers.
Switzerland	Only the provider of the universal service makes the measurements. Therefore there is only one interpretation, no comparison among different providers. The measurements base on the ETSI standard EG 202 057-4.

9. Is your institution dealing with end users' complaints?	
Austria	Yes
Croatia	Yes
Denmark	Yes
Finland	Yes – to the extent stipulated in our legal instruments.
Germany	Yes
Latvia	Yes. According to the Law "On Public Utilities Regulators" PUC is responsible for users' complaints resolution in electronic communications
Lithuania	Yes
Montenegro	Yes, it is. According to the Law of electronic communications, public communications service users and operators shall have the right to file complaints to the Agency with regard to approach to and provision of services.
Norway	No, individual complaints on contracts with ISPs are handled by a separate complaints body
Poland	Yes, there is a special department that is dealing with it.
Portugal	Yes
Romania	As we have said, the abovementioned decision doesn't impose any minimum QoS requirements on an undertaking providing Internet Access. The National Authority for Consumer's Protection is empowered to receive complaints about the failure to comply with the contractual obligation established between end-users and ISPs.
Spain	YES. The Office for telecom customers is the specific department within the MITYC that centralises the activities regarding users' rights and implements an off-court resolution system as the referred to in Art. 34 of US Directive.
Sweden	Yes, the end users can inform PTS about complaints. PTS does not solve disputes between a service provider and an end user.
Switzerland	Not formally. Users have to address complaints to their service provider. If provider and users don't find an agreement, the user can contact a conciliation organization (www.ombudscom.com). Our office doesn't supervise nor measure performance indicators of an individual Internet connection. The office collects and classifies user's complaints but for the moment there is no statistical evaluation of the complaints.

10. Do you have any legal act which specifies the minimum service quality levels for Internet Access to be included in end users' contract?	
Austria	No.
Croatia	At the moment a USO operator must offer an Internet Access of 144 kbit/s or higher. From 1 January 2015. USO operator is obliged to offer an Internet Access of 1 Mbit/s or higher. Also, according to the Ordinance on manner and conditions for the provision of Electronic communications networks and services, Operators of public communications services in fixed network must advertise minimum broadband speed rates in the same manner as maximum broadband speed rates. Operators must define the minimum broadband speed for all of their packages which contain the broadband access service: a) up to 10 Mbit/s in such a manner that it represents at least 50% of the maximum (advertised) broadband speed during peak traffic (19-23h) or maximum speed of the closest lower retail package, depending on what is more favourable for the end user b) above 10 Mbit/s in such a manner that it represents at least 70% of the maximum (advertised) broadband speed during peak traffic (19-23h) or maximum speed of the closest lower retail package, depending on what is more favourable for the end user. Operators of public communications services in mobile networks must advertise broadband speed in such a way that it is clearly indicated for a certain speed rate that it may be achieved only under certain conditions (the above-mentioned text must of the same size and in the same font).
Denmark	No, apart from the Universal Service provider being obliged to provide fixed lines capable of functional internet access.
Finland	There is in Finland at the moment a USO (Universal Service Obligation) requirement set to SMP (Significant Market Power) operators to offer an Internet Access of 1 Mbit/s or higher. In our legal instruments the minimum transmission rate for 1Mbit/s access is specified as follows: - The minimum average transmission rate in downstream direction must be at least 750 kbit/s during any 24 hours long time period and - The minimum average transmission rate in downstream direction must be at least 500 kbit/s during any 4 hours long time period.
Germany	Compare Question 6.
Latvia	General Authorisation Requirements issued by PUC of Latvia specifies quality requirements should be included in the consumer contracts.
Lithuania	Yes. The internet service provider is obliged to state minimum download/upload data rate for his provided internet services in the contract with the customer. Also service availability percentage should be stated in the contract.
Montenegro	Rulebook for quality of service for Universal Service, specifies that data transfer speed that is necessary for functional Internet access is measured in accordance with definitions and methods specified according to the technical information METI ETSI EG 202057-1, and the exit velocity ("upload) and the input speed ("Download") are measured separately. At least 95% of the line must be achieved data rate required for a functional

	approach internet.
Norway	No
Poland	See reply to point 6
Portugal	ANACOM published guidelines that defined the minimum content to be included in contracts for publicly available telephone services (mobile or at a fixed location) and for Electronic communications Services (other than publicly available telephone services), in which some mandatory particulars must be included, namely, quality of service levels supplied and required time for start-up connections. Specifically: The contract must establish the obligation upon undertakings to provide regular and uninterrupted service. The contract must clearly set the levels of quality which the service provider undertakes to uphold with its customers, i.e. the minimum (target) service levels of quality to which the customer is entitled, non-compliance with which determines the payment of compensation or reimbursement. Given that service providers have voiced uncertainties with regard to parameters concerning which levels of quality should be set, ANACOM in Appendix I of those guidelines suggests some parameters. This does not preclude service providers from including additional indicators which they may deem relevant, nor does it rule out the possibility of ANACOM eventually instituting specific parameters of quality under the terms of article 40 of the Electronic Communications Law, for the purpose of publishing and providing end users with comparable, clear, comprehensive and up-to-date information on quality of service. In the event that the service provider does not wish to provide or otherwise undertake to uphold any level of quality of service, this must be clearly stated in the contract.
Romania	According with the above mentioned decision providers have the obligation to include in the contracts the levels of service quality **offered to the end-users**. This decision aims at defining the quality parameters for the Internet Access Service and their measurement methods, and not at imposing target values for these parameters. The assumed value of parameters (the quality level) is to be established under the contract for the provision of Internet access services concluded with the end-user.
Spain	NO. The M.O. ITC/912/2006 establishes that contracts shall include the commitments on QoS parameters (at least regarding maximum interruption time during a billing period, other compromises are optional), the compensation in case of non-compliance and the procedure to make effective the compensation, but it does not specifies minimum service quality levels.
Sweden	The Swedish electronic act states that minimum service quality should be included in the contract. Minimum service quality levels could be defined in secondary legislation. At the time being no such secondary legislation is in force.
Switzerland	No

11. Does your institution performs the measurements/evaluation of QoS parameters of Retail Internet Access in the context of dealing with end users' complaints?

Austria	No.
Croatia	Yes. HAKOM (Inspection Department) has its own equipment for testing QoS parameters, and uses these tools when it is necessary use these tools. HAKOM created and made available to the users an application for checking users' broadband speeds.
Denmark	No
Finland	We used to do that - but not anymore. Operators/Providers must have that capability; see - Regulation 58 Section 3 and 5 (Special requirements for internet access services). - Explanatory Notes to Regulation 58 section 9 (Recommendations on provision of Internet Access Services) http://www.ficora.fi/en/index/saadokset/maaraykset.html
Germany	No
Latvia	PUC performs the measurements of the quality parameters for Internet Access services in cases when PUC receives a complaint from end users about the quality.
Lithuania	Yes
Montenegro	No.
Norway	No, only in case of severe radio interference degrading end user services
Poland	UKE has its own equipment for testing QoS parameters, and uses these tools when it is necessary use these tools. UKE also uses the services of a third party (independent measurement companies and institutions).
Portugal	No
Romania	Regarding technical parameters, ANCOM will create, manage and make available to the users an application meant to measure these parameters. Most contracts contain the maximum/ nominal transfer speed, the service being provided as best effort type.
Spain	YES. In case a user' complaint on Internet access malfunction is received, the Inspection Department can verify the Internet access' speed and its performance.
Sweden	No, another organization is doing that. .SE (The Internet Infrastructure Foundation) is an independent organization for the benefit of the public that promotes the positive development of the Internet in Sweden. The Broadband Check is a consumer tool for checking your broadband connection. It provides a simple way of testing your broadband speed directly in your web browser. You can find out if you have the right speed and if you get what you are paying for.
Switzerland	No

12. What Internet Access QoS parameters does your institution evaluate?

Austria	N/A
Croatia	Download speed, Mbit/s
Denmark	N/A
Germany	As of today, none
Latvia	- Download and upload speed, Mbit/s - Latency, ms - Jitter, ms - Packet loss, %
Lithuania	Service Non-Accessibility; Data Transfer Setup Time; Mean Data Rate; Data Transfer Cut-off Ratio, Latency, Jitter, Lost Packet Ratio.
Norway	QoS data on ISP customer service availability and response time are evaluated.
Poland	See Annex 1 and Annex2 to the Position of the President of UKE http://www.uke.gov.pl/uke/index.jsp?place=Lead01&news_cat_id=470&news_id=7181&layout=3&page=text
Portugal	In the periodic tests performed by ANACOM, the followings QoS parameters are evaluate: Service access failure; Causes of failed service access; Activation/connection time; Latency; Time to load a page (web browsing); File transfer speed; Loss of Packets; Jitter; DNS (Domain Name System) resolution time.
Romania	See question 4.
Spain	The definition and measurement method of the QoS parameters referred to the connection providing universal service are under study. Regarding to transparency on QoS, each service provider has to implement QoS measurement system covering the most relevant services commercialised. The set of QoS parameters comprises general parameters measured together with the telephone service (Supply time for fixed access network, response time for admin/billing enquiries, frequency of customer complaints, customer complaints resolution time and bill correctness complaints), non-technical specific parameters for Internet access service (supply time for Internet access (over line in service), fault report rate per fixed access lines (from Q4 2011), fault repair time for fixed access lines (from Q4 2011)) and technical specific parameters (successful log-in ratio, unsuccessful data transmission ratio and download data transmission speed achieved)). The MITYC does not measure any QoS parameter, but supervises and enforces of service provider's obligations.
Sweden	N/A
Switzerland	See question 4

13. Which of them are the most important to evaluate overall Internet Access quality for end users?	
Austria	N/A

<table>
<tr><td>Croatia</td><td>Connection speed</td></tr>
<tr><td>Denmark</td><td>N/A</td></tr>
<tr><td>Finland</td><td>Connection speed, overall maintenance, response time of DNS resolver, access control and DHCP services as described in Regulation 28 section 5 - but performed by operators/providers.
http://www.ficora.fi/en/index/saadokset/maaraykset.html</td></tr>
<tr><td>Germany</td><td>N/A</td></tr>
<tr><td>Latvia</td><td>The importance of QoS parameters depends on end user activities on the Internet, for example, for file downloading important are download speed and packet loss, but for VoIP and IPTV more significant are latency and jitter.</td></tr>
<tr><td>Lithuania</td><td>Mean Data Rate</td></tr>
<tr><td>Poland</td><td>See Annex 1 and Annex 2 to the Position of the President of UKE http://www.uke.gov.pl/uke/index.jsp?place=Lead01&news_cat_id=470&news_id=7181&layout=3&page=text</td></tr>
<tr><td>Portugal</td><td>It depends on the application, but latency and loss of packets are quite important because of VoIP. The following table from ITU-T clarifies it better:
<table>
<tr><th rowspan="2">Service</th><th colspan="2">Speed</th><th colspan="2">Delay</th><th rowspan="2">Loss</th></tr>
<tr><th>Downstream</th><th>Upstream</th><th>RTT</th><th>Jitter</th></tr>
<tr><td>Browse (text)</td><td>++</td><td>-</td><td>++</td><td>-</td><td>-</td></tr>
<tr><td>Browse (media)</td><td>+++</td><td>-</td><td>++</td><td>+</td><td>+</td></tr>
<tr><td>Download file</td><td>+++</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Transactions</td><td>-</td><td>-</td><td>++</td><td>+</td><td>-</td></tr>
<tr><td>Streaming media</td><td>+++</td><td>-</td><td>++</td><td>++</td><td>++</td></tr>
<tr><td>VoIP</td><td>+</td><td>+</td><td>+++</td><td>+++</td><td>+++</td></tr>
<tr><td>Games</td><td>+</td><td>+</td><td>+++</td><td>++</td><td>++</td></tr>
</table></td></tr>
<tr><td>Romania</td><td>We consider them equally important. The significance of each parameter depends on the type of application used.</td></tr>
<tr><td>Spain</td><td>All of them are important but end users mainly focus on data transmission speed.</td></tr>
<tr><td>Sweden</td><td>N/A</td></tr>
<tr><td>Switzerland</td><td>The parameters relate only to the quality of IP packet transmission between “Network termination point” at the modem/router in the home and the test server in the network of the Internet provider. There are no measurements of the overall Internet access quality as experienced by an end user.</td></tr>
</table>

14. What standards/recommendations does your organization apply to define Internet Access QoS parameters as well as their evaluation methods?	
Austria	N/A
Croatia	The ETSI EG 202 057 principles were used to define Internet Access QoS parameters where applicable.
Denmark	N/A

Finland	As described in section 17 (page 39) of Explanatory Notes to Regulation 58 http://www.ficora.fi/en/index/saadokset/maaraykset.html
Germany	As of today, none. If BNetzA will define QoS requirements for Retail Internet Access these would be in line with those international standards that suit best the aim of the chosen measurement system.
Latvia	The ETSI EG 202 057principles were used to define Internet Access QoS parameters.
Lithuania	RRT has a developed Internet Access QoS evaluation methodology approved by the order of Director of RRT based on ETSI EG 202 057 - 4 V1.2.1 (2008-07) (angl. „Speech Processing, Transmission and Quality Aspects (STQ); User related QoS parameter definitions and measurements; Part 4: Internet access) where all KPIs are defined and measurement methods described.
Norway	ETSI EG 202 057 is used for reference where applicable
Poland	See Annex 1 and Annex 2 to the Position of the President of UKE http://www.uke.gov.pl/uke/index.jsp?place=Lead01&news_cat_id=470&news_id=7181&layout=3&page=text
Portugal	The tests performed to produce the periodic report on the QoS Internet access are based on the ETSI guides EG 202 057-1 (User related QoS parameter definitions and measurements; Part 1: General) and EG 202 057-4 (User related QoS parameter definitions and measurements; Part 4: Internet access) and the ITU-T recommendations Y.1541 (Network performance objectives for IP-based services) and G.1010 (End-user multimedia QoS categories).
Romania	Decision no.1201/2011 follows recommendations given in ETSI EG 202 057 – 1 – Speech processing, Transmission and Quality Aspects (STQ); User Related QoS parameter definitions and measurements; Part 1: General and ETSI EG 202 057 – 4 Speech processing, Transmission and Quality Aspects (STQ); User Related QoS parameter definitions and measurements; part 4: Internet Access, but we also have taken into consideration the following documents: ITU-T Y.1540 - Internet protocol data communication service –IP packet transfer and availability performance parameters, ITU-T Y.1541 Network performance objectives for IP-based services, ITU-T G.1000: "Communications quality of service: A framework and definitions, ETSI EG 202 009-1: "User Group; quality of telecom services; Part 1: Methodology for identification of parameters relevant to the Users", ETSI EG 202 009-2: "User Group; Quality of telecom services; Part 2: User related parameters on a service specific basis", ETSI EG 202 009-3: "User Group; Quality of telecom services; Part 3: Template for Service Level Agreements (SLA)", ITU-T Recommendation E.800: "Terms and definitions related to quality of service and network performance including dependability".
Spain	The definition and measurement method are based on ETSI EG 202 057, parts 1 to 4, and additional requirements developed by the QoS working group which complement the method described in the ETSI guide.
Sweden	N/A
Switzerland	ETSI EG 202 057-1, ETSI EG 202 057-4

15. Does your institution have its own Internet Access QoS parameters measurement system or does it use systems belonging to another institutions/organizations?	
Austria	N/A
Croatia	HAKOM has own Internet Access service quality measurement system. Also an own online broadband measurement tool (HAKOMetar) has been developed.
Denmark	N/A
Finland	We used to have – but not anymore
Germany	N/A
Latvia	PUC has own Internet Access service quality measurement system.
Lithuania	RRT has two sets of own equipment for measuring Internet Access QoS parameters. One for testing services of mobile internet access service providers, and other is a web-page based data rate evaluation tool www.matuok.lt designed for all Lithuanian Retail Internet Access end users
Norway	An own online broadband measurement tool has been developed
Poland	See reply to point 11
Portugal	No. The study and the tests were made by subcontracting external companies.
Romania	Most likely, ANCOM will use the services of a company specialized in measuring Internet Access Service quality, but the application will be tailored to ANCOM requirements.
Spain	The measurement system is implemented by each service provider. Basically, general and non-technical QoS parameters are derived from information collected by each service provider (e. g. CRM). Besides, in order to measure the technical specific parameters each ISP have to deploy a number of test probes dependant on the total amount of customers and perform measurements against a server at ISP's network with a periodicity of at least every 20 minutes. The measurements collected during the period are averaged and weighted according to its traffic pattern.
Sweden	N/A
Switzerland	No. The provider of the universal services measures itself (partly with 3rd organisation). The private institution "Cnlab" collaborates with several ISPs in Switzerland. Users can measure their Internet speed with http://www.cnlab.ch/speedtest/.

16. If your institution has own Internet Access QoS parameters measurement system please describe them:	
Austria	N/A

Germany	(-)
Portugal	Not applicable
Sweden	N/A
Switzerland	Not applicable
a. Please provide a rough sketch of your measurement system.	
Croatia	The measurement tool (Java based client application) measures upstream/downstream capacity and ping. Two sets of measurement : measuring the availability of data content at the reference servers (CIX) and measuring the availability of data content on the Internet (establishment of a large number of simultaneously HTTP and FTP connections to the data content on the Internet). The data results are recorded locally on the user's computer na on HAKOM server. End user has possibility to use the results of measurements in the process of resolving complaints.
Latvia	The measurement system is arranged as the server connected to the National Internet Exchange points. System engine is built as Java application with the system core from Visualware http://www.visualware.com (MyConnection Server BusinessCenter) and with interactive web interface which developer is the Latvian company . This measurement system measures download and upload speed, latency, jitter and lost packets. The measurements are performed from the Network termination point to Latvian Internet Exchange point.
Lithuania	Internet access service evaluation system for home users: Dedicated web-page with online speed measurement software accessed by end users via internet browser. Mobile telephony services evaluation system: “Ascom” system x1000 with integrated modems, control interface and measurement data processing database. This system is designed for Voice and Internet Access services evaluation. Additional independent equipment is used for mobile internet access KPI evaluation: Laptop computer with connected 3G and WiMAX modems. The computer runs an automated script to perform measurements. This system can be left without manual attention in different locations to evaluate QoS in specific geographical areas around the clock.
Norway	The measurement tool measures latency and upstream/downstream capacity from the user’s broadband access to the largest national Internet exchange point. It also offers measurement statistics and provides user guidance.
Poland	UKE has a nGenius System (Netscout USA) www.nescout.com
b. On which OSI level does the system work (IP, Application, etc.)?	
Croatia	Application layer (HTTP)
Latvia	Transport level; used TCP and UDP
Lithuania	Application

Norway	The system measures capacity and latency related to the Application layer (HTTP).
Poland	nGenius examines the quality of services in the transport layer and higher layers up to the application layer (the measurement is based on passive observation of the data stream passing through the probe).
c. Does your system provide statistical Internet Access QoS parameters figures? If yes, please describe for what period and how many samples your system performs to evaluate statistically consistent QoS parameters.	
Croatia	Data collected from the measurements using HAKOMetar tool is not analysed and statistical figures are not publicly provided.
Latvia	Today the data base saves four years statistics. It is possible to define a time frame or ISP or IP address to select statistical dates. To analyse the statistics the additional application is used.
Lithuania	Data collected from the measurements using www.matuok.lt service is not analysed and statistical figures are not provided. Data of mobile internet access evaluation system is analysed and annual reports are published. Most of statistical figures are calculated manually. We try to collect as many data samples throughout the year across different cities in Lithuania. Last year over 6k of data samples for Mobile Internet Access QoS evaluation were collected, this year it is already over 30k data samples for all Mobile ISPs.
Norway	Users can choose to save their measurement result to a database. Provided the measurement passes a set of quality filters, it will be added to the statistics database. For each Internet access product (e.g. 25/25 Fibre, 8/1 ADSL) the statistics section of the measurement tool can be filtered by the user according to upload or download capacity and latency. Statistics can be divided into monthly time frames.
Poland	Every 15 minutes, spacecraft "throws" statistics data to the measuring server nGenius (UKE). It is a passive system (inactive) - there are so many attempts on current user activity. The system maintains data from the 2 months period.
Romania	We intend to publish statistical data quarterly concerning all 4 technical parameters, based on the tests users perform.
d. What Internet destination address (es) (servers) does your system utilize in order to evaluate Internet Access QoS parameters (popular national websites, popular international websites, governmental organizations websites, special servers placed in IXP, Internet Access provider's servers, etc.)	
Croatia	In first step "measuring the availability of data content at the reference servers" the network destination address for measurement is the Croatian Internet eXchange point in CARNet (CIX). In second step "Measuring the availability of data content on the Internet " network destination addresses for measurement are large number web addresses (for process establishment of a large number of simultaneously HTTP and FTP connections to the data content on the Internet).
Latvia	Destination addresses on special servers placed in National Internet Exchange point (IXP)

Lithuania	RRT uses a dedicated server which hosts data files of particular size and ETSI recommended web-page for QoS evaluation “Copernicus”.
Norway	The network destination address for measurement is the Norwegian Internet eXchange point in Oslo (NIX).
Romania	The application will test the quality of the service or the link between the end-user’s terminal equipment and a testing server located in an interexchange internet node.

17. Has your measurement system being utilized to solve users’ complaints?	
Austria	N/A
Croatia	Yes. According to the Ordinance on manner and conditions for the provision of Electronic communications networks and services, if an end user complains against broadband speed (in fixed electronic communications network), the end user must submit to the operator the results of at least seven (7) tests conducted during peak traffic (19-23h) in a period of ten (10) consecutive days and at least one test must be carried out every 24 hours. Tests are carried out by means of a certified tool for broadband speed tests- HAKOMetar. The results of the tests represent adequate proof in the procedure for the resolution of complaints made by end users and tests may be repeated by the operator and /or HAKOM, depending on the circumstances.
Denmark	N/A
Germany	N/A
Latvia	Yes. Additional testing equipment (Probe) to be connected to Network Termination Point in customer premises is used together with the measurement system.
Lithuania	No, for www.matuok.lt .Yes, for mobile internet access.
Norway	It is available on a voluntary basis and can be used by everyone. Users can share their measurement results with their ISP, in case of a complaint.
Poland	Yes
Portugal	No
Romania	This measurement system isn’t going to be utilized to solve users’ complaints
Sweden	N/A
Switzerland	Not applicable

18. Is it possible for Internet Access Service Providers (ISP) to use your Internet Access QoS parameters measurement system?	
Austria	N/A
Croatia	HAKOMetar is publicly available, so ISPs can use it any time.
Denmark	N/A
Germany	N/A
Latvia	Yes
Lithuania	The web-page internet speed evaluation application www.matuok.lt is publicly available, so ISPs are free to use it any time.
Norway	Yes
Poland	We have not yet identified such points of access to measurements of Internet access services. UKE strives to make such items available by vendors for purposes of measurement.
Portugal	No
Romania	This measurement system will be used only by the end users.
Sweden	N/A
Switzerland	Not applicable

19. If yes, is it free of charge or do ISPs have to pay for measurements?	
Austria	N/A
Croatia	Free of charge.
Germany	N/A
Latvia	Any ISP may have the access to this system free of charge. For the security reason they have to sign the agreement with PUC. After the agreement is signed ISP receives from PUC username and password to access the measurement system.
Lithuania	No
Norway	Free of charge
Poland	We have not considered this option yet.
Portugal	Not applicable
Sweden	N/A
Switzerland	Not applicable

20. Is it possible for Retail Internet Access end users to use your Internet Access QoS parameters measurement system?	
Austria	N/A
Croatia	Yes. HAKOMetar is designed for end users and is publicly available
Denmark	N/A
Germany	N/A
Latvia	Yes
Lithuania	Yes, for the web-page internet speed evaluation application www.matuok.lt. It is designed for Retail end users and is publicly available.
Norway	Yes, it is available for all interested parties
Poland	N/A
Portugal	Not for the existing system methodology, but it will be possible in the future
Romania	Yes, the system is meant to serve end-users
Sweden	N/A
Switzerland	Not applicable

21. If yes, is it popular among end users?	
Austria	N/A
Croatia	Yes, more than 24 000 measurement in 4 months from releasing
Germany	N/A
Latvia	Yes, more than two thousands measurement sessions fixed in measurement system database each month.
Lithuania	To this date in year 2011 www.matuok.lt has generated about 500 visits per day on average.
Norway	Yes, the service has more than 50 000 visitors each month.
Poland	N/A
Portugal	In the future there will be two different solutions: one based on an agent based application and a second one based on a web based application.
Romania	This measurement system isn't implemented yet.
Sweden	N/A
Switzerland	Not applicable

	Austria	Croatia	Denmark	Finland	Germany	Latvia	Lithuania	Montenegro	Norway	Poland	Portugal	Romania	Spain	Sweden	Switzerland
Supervision of QoS for electronic communications services	Yes, US	Yes	Yes	Yes, Voice, Internet, US	Yes, US	Yes	Yes	Yes	Yes	Yes	Yes	Yes, US	Yes	Yes	Yes, US
QoS requirements (parameters, Key Performance Indicators (KPI)) for Residential Internet Access	No, but they plan	Yes	No	Yes	No, but they plan	Yes	Yes	Yes	No, as guideline	Yes	No, but they plan	Yes	Yes	No	Yes, US
Deal with end users' complaints	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No
Minimum service quality requirements for Internet Access which to be included in end users' contracts	No	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	No
Providing the measurements/evaluation of QoS parameters of Residential Internet Access in the context of dealing with end users' complaints	No	Yes	No	No	No	Yes	Yes	No	No	Yes	No	No	Yes	No	No
Evaluated QoS parameters:															
Data speed	N/A	Yes	N/A	N/A	N/A	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	N/A	Yes
Other parameters (e.g. latency, packet loss)	N/A	No	N/A	N/A	N/A	Yes	Yes	N/A	Yes	Yes	Yes	Yes	Yes	N/A	Yes
Is own Internet Access QoS parameters measurement system	N/A	Yes	N/A	N/A	N/A	Yes	Yes	N/A	Yes	Yes	No	No	No	N/A	No

ANNEX 2: PUBLICATION OF ESTIMATED (PLANNED) VALUES

A.2.1 Publication of estimated (planned) values for new Internet Access offers and for new undertakings

New Internet Access offer ISP cannot publish statistical (measured) QoS information since the service is not actually being provided. However some estimated (planned) QoS values should in principle be available while ISP dimensions and adjusts the network for provision of new service.

Obligation to provide estimated QoS values for newly launched Internet Access services is rather rare practice at the moment, however from the standpoint of the end user QoS information should still be available even in case the service is new.

According to the experience from the field, practical application of such obligation may be considered as rather beneficial for the end user while planned values were being estimated quite precisely.

A.2.2 Publication of estimated (planned) values on regular basis

Taking into account flexibility of the relevant USD provisions, some NRAs may consider it beneficial to provide end users with information not only about the actual QoS values, but also about estimated (planned) QoS values for a defined period of time, e.g. next calendar year. In this case NRAs should oblige ISPs to publish and (or) to submit their plans for QoS values for the defined time horizon (QoS Declaration).

In this case a QoS Declaration is published by an ISP entering the market or providing a new Internet access offer. The declaration should then be updated at defined intervals e.g. once a year. Received QoS declarations should be published on the NRAs web site.

In case the estimated (planned) QoS values will be published, the publishing form as in Table 8.1 may be used and it will be placed together with the form with measured values for easy comparison.

ANNEX 3: LIST OF REFERENCES

[1] Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services.

[2] Directive 2009/136/EC of the European Parliament and of The Council of 25 November 2009 amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services, Directive 2002/58/EC concerning the processing of personal data and the protection of privacy in the electronic communications sector and Regulation (EC) No 2006/2004 on cooperation between national authorities responsible for the enforcement of consumer protection laws.

[3] A framework for Quality of Service in the scope of Net Neutrality, BEREC, 8 December 2011.

[4] Guidelines for Quality of Service in the scope of Net Neutrality - Draft for public consultation, BEREC.

[5] ETSI EG 202 057-1 V1.3.1 (2008-07) Speech Processing, Transmission and Quality Aspects (STQ); User related QoS parameter definitions and measurements; Part 1: General.

[6] ETSI EG 202 057-4 V1.2.1 (2008-07) Speech Processing, Transmission and Quality Aspects (STQ); User related QoS parameter definitions and measurements; Part 4: Internet access.

[7] ETSI TS 102 250-1 V2.2.1 (2011-04) Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in mobile networks; Part 1: Assessment of Quality of Service.

[8] ETSI TS 102 250-2 V2.2.1 (2011-04) Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in mobile networks; Part 2: Definition of Quality of Service parameters and their computation.

[9] ETSI TS 102 250-3 V2.2.1 (2011-04) Speech and Multimedia Transmission and Quality (STQ); QoS aspects for popular services in mobile networks; Part 3: Typical procedures for Quality of Service measurement equipment.

[10] ETSI TS 102 250-4 V2.2.1 (2011-04) Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in mobile networks; Part 4: Requirements for Quality of Service measurement equipment.

[11] ETSI TS 102 250-5 V2.2.1 (2011-04) Speech and multimedia Transmission Quality (STQ); QoS aspects for popular services in mobile networks; Part 5: Definition of typical measurement profiles.

[12] ETSI TS 102 250-6 V1.2.1 Speech Processing, Transmission and Quality Aspects (STQ); QoS aspects for popular services in GSM and 3G networks; Part 6: Post processing and statistical methods.

[13] ETSI EG 203 165 V 1.1.1 (2012-04) Speech and multimedia Transmission Quality (STQ); Throughput Measurement Guidelines.

[14] ETSI EG 202 765-3 V 1.1.2 (2010-07) Speech and multimedia Transmission Quality (STQ); QoS and network performance metrics and measurement methods; Part 3: Network performance metrics and measurement methods in IP networks.

[15] ITU-T Recommendation Y.1540 (03/2011) Internet protocol aspects – Quality of service and network performance; Internet protocol data communication service –IP packet transfer and availability performance parameters.

[16] ITU-T Recommendation Y.1541 (12/11) Internet protocol aspects – Quality of service and network performance; Network performance objectives for IP-based services.

[17] ITU-T Recommendation P.800 (08/96) Series P: Telephone transmission quality; Methods for objective and subjective assessment of quality; Methods for subjective determination of transmission quality.

[18] ITU-T Recommendation P.910 (04/08) Series P: Telephone transmission quality; Methods for objective and subjective assessment of quality; Subjective video quality assessment methods for multimedia applications.

[19] ITU-R Recommendation BS.1116-1 (10/97) Methods for the subjective assessment of small impairments in audio systems including multichannel sound systems.

[20] ITU-R Recommendation BT.500-13 (01.12) Methodology for the subjective assessment of the quality of television pictures.

[21] ITU-T Recommendation G.1010 (11/01) End-user multimedia QoS categories.

[22] ITU-T Recommendation E.800 (09/2008) Definitions of terms related to Quality of Service.